From N. H. Winchell. Feb 20, '78

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# THE GEOLOGICAL

AND

# NATURAL HISTORY SURVEY

OF

# MINNESOTA.

## THE FIFTH ANNUAL REPORT.

FOR THE YEAR 1876.

*OFFICERS OF THE SURVEY:*

N. H. WINCHELL, STATE GEOLOGIST............In charge.
S. F. PECKHAM................................Chemistry.
M. D. RHAME..................................Topography.
P. L. HATCH..................................Ornithology.
ALLEN WHITMAN................................Entomology.
CLARENCE HERRICK...........Laboratory Assistant.

SUBMITTED TO THE PRESIDENT OF THE UNIVERSITY. DEC. 31, 1876.

ST. PAUL:
PIONEER PRESS COMPANY.
1877.

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# THE BOARD OF REGENTS OF THE UNIVERSITY.

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# ADDRESS.

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THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1876.

*To the President of the University:*

DEAR SIR:—I have the honor to offer, and to transmit through you to the Board of Regents of the State University, the Annual Report required by law on the progress of the Geological and Natural History Survey of the State, being the fifth since the beginning of the survey.

Very respectfully,
Your obedient servant,
N. H. WINCHELL.

## STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

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1. *Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey.* 84 *pp.* 1860. *Reprint from the Wisconsin Reports for* 1858. *Out of print.*
2. *Statistics and History of the Production of Iron, by A. S. Hewitt.* 47 *pp.* 1860. *Reprint of a paper read before the American Geographical and Statistical Society, January* 31, 1856. *Out of print.*
3. *Report of Anderson and Clark, Commissioners on the Geology of the State, January* 25, 1861. *8vo.* 26 *pp. Out of print.*
4. *Report of Hanchett and Clark, November,* 1864. *8vo.* 82 *pp. Out of print.*
5. *Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior,* 1866. *8vo.* 28 *pages.*
6. *Report of H. H. Eames, on some of the northern and middle counties of Minnesota.* 1866. *8vo.* 58 *pp. Out of print.*
7. *Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota.* 1866. *8vo.* 52 *pp. close type, with wood cuts.*
8. *Report of N. C. D. Taylor on the Copper District of Kettle river, incorporating Mr. James Hall's estimate of the copper prospects of that district,* 1866. 2 *pp. 8vo. Found only in the Executive Documents.*
9. *Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June* 17, 1871. *8vo.* 16 *pp.*
10. *The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year* 1872. *By N. H. Winchell. 8vo.* 112 *pp. with a colored geological map of the State. Published in the Regents' Report for* 1872. *Out of print.*
11. *The Second Annual Report on the Geological and Natural History Survey of the State, for the year* 1873. *By N. H. Winchell and S. F. Peckham. Regents' Report*; 148 *pp. 8vo.*; *with Illustrations.*
12. *The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year* 1874. *By N. H. Winchell.* 41 *pp. 8vo. with two county maps. Published in the Regents' Report for* 1874.
13. *The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year* 1875. *By N. H. Winchell, assisted by M. W. Harrington*; 162 *pp.* 8*vo*; *with four county maps and a number of other illustrations. Also published in the Regents' Report for* 1875.

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[NOTE.—Of the foregoing, Nos. 1, 2, 4 and 6 are wanted by the Survey.]

# REPORT.

## I.

## SUMMARY STATEMENT.

The field work of the survey was continued during a portion of the season of 1876, in the southeastern portion of the state, where the county of Houston, which borders on the Mississippi river, was examined in detail, and is herewith reported, with the necessary maps and diagrams. Later in the season the county of Hennepin was surveyed in the same manner. It was hoped that by an examination of these two counties, the latter of which embraces the interesting locality of the Falls of St. Anthony, which have receded several miles up the Mississippi from the point at which they existed in earlier geological ages, some new light would be thrown on some of the problems that invest the history of the drift, and which have presented themselves in new phases in the counties of Fillmore and Houston. In the detailed reports on Hennepin and Houston counties these problems are briefly discussed, in the light of such facts as we possess. In the further examination of the region of the Falls of St. Anthony, which embraces parts of the counties of Ramsey, Washington ad Dakota, the remainder of the great gorge excavated by the recession of the falls will come under careful inspection. Until these counties are surveyed the history of this excavation cannot be given. Some progress has, however, been made in this interesting investigation.

In the latter part of August an examination of the fossils of the Trenton was begun, including those of the Galena division. This is our chiefly fossiliforous formation. Favorable opportunities for collecting fossils from the Lower Trenton exist at Minneapolis and at St. Paul. Tolerably full collections of its fossils are found in the possession of the survey, which, added to those of the Academies

of Science at St. Paul and Minneapolis, will make it possible to give, finally, a pretty good description of the Trenton fauna, as exemplified in Minnesota. In this examination, which is but just begun, there have been identified, at least provisionally—

10 species of Cephalopoda.
11 species of Gasteropoda.
11 species of Brachiopoda.
8 species of Polyp Radiates.
2 species of Crustacea.
2 species of Protozoa.

These are entirely from points in the southern part of the state. Several species have been met with that cannot be identified by any published descriptions, and a few drawings have been made.

In this connection should be mentioned the interesting fact that some indications have been discovered of an unconformability between the Devonian and Silurian which will necessitate changes in the colored county maps that have been published. This evidence is at present entirely of a palæontological character, and shows the necessity of keeping that branch of the work abreast of the field work. In the western part of Fillmore county the Niagara limestone seems to be wanting, or at least reduced to in significant dimensions, since the Lower Devonian, or what has been regarded hitherto as rock of that age, lies but a few feet above that which contains undoubted Trenton fossils. Further examination of these outcrops is needed before the question can be fully settled.

In respect to the chemical work of the survey the report of Prof. Peckham shows what has been done. It is highly desirable that there be no further obstacles to the vigorous prosecution of the chemical investigations. The laboratory is now completed and well equipped.

In December, 1875, the Board of Regents took action ordering the commencement of thorough botanical observations, and the collection of specimens at the State University. A circular was issued asking the co-operation of the botanists of the state, and prescribing general directions for the work. A number of favorable responses have been received, and several valuable papers on the flora of different localities have been contributed. This portion of the work of the survey seems to have been eagerly taken hold of, and there is every prospect that the botany of the state will be thoroughly and at the same time economically worked up. Ultimately the aid of an expert will be needed to compare and

digest the material that may be gathered. It will certainly be vastly cheaper, as well as more satisfactory to the people of the state, to carry on this great work of a state survey *as a unit,* with its different parts in harmony where each can aid the other by the various opportunities that arise, than by scattering it along so that each part is done separately. This is particularly true of the field-work. This economy and co-operation is so palpably essential that it has already been demanded by the intelligent press of the state.*

The Board of Regents have also taken action looking to the examination of the ornithology of the state, in the appointment of Dr. P. L. Hatch as ornithologist. His results, heretofore published only in the Proceedings of the Minnesota Academy of Natural Science, will hereafter be reported to the survey, and ultimately a complete memoir on the Birds of Minnesota will be prepared. It is to be regretted that some such action had not been taken before, since many good specimens, and needed information from different parts of the state might have been secured with but little extra expense, in the prosecution of the field-work of the survey. Mr. Herrick has also collected about a hundred species of birds in the immediate vicinity of Minneapolis, which are stored in the Museum.

The entomology of the state was also begun by the Board of Regents the past year, by the appointment of an entomologist to the survey, and his first report is herewith published. He was instructed to confine himself to an investigation of insects injurious to farm products, especially to the ravages of the Rocky Mountain locust. This investigation was begun the year before by Mr. Whitman, under instructions from Gov. C. K. Davis.

Further correspondence has been had with Col. C. B. Comstock, in charge of the United States survey of the lakes, in reference to the determination of the latitude and longitude of points in Minnesota by the officers of the Lake Survey. At his request certain points were designated, the latitude and longitude of which, if ascertained, would aid the Geological and Natural History Survey of the state. In connection with the survey of Houston and Hennepin counties the usual topographical data are given.

A complete series of meteorological observations should be established at the State University. They are especially appropriate to the Agricultural College. The law ordering the survey requires the tabulation of statistics relating to the weather, and the investi-

* Compare the First Annual Report on the progress of the survey, Regents' Report, pp 41, 44, and 119: also the Fourth Annual Report, p. 11.

gation of the climate of Minnesota. An incomplete series of observations has been kept up by the writer at Minneapolis since the beginning of the survey and reported to the Chief Signal Officer of the Army at Washington. It requires, however, an outlay of about one hundred dollars for instruments to carry on the full series of observations contemplated by the Chief Signal Officer. To make a comparative study of the climate of Minnesota and of the northwest, with a view to the elimination and explanation of any peculiarities that Minnesota may possess, the observations of many observers at widely distant points must be collated. It is hoped that the survey may be able to avail itself of, if not to institute, complete observations made at the University. The Monthly weather Reviews, which are received regularly by the University Library, will be of the greatest service in accomplishing this work.

The year has been one of special activity in the University Museum. Besides the display of the casts of fossils purchased of Prof. H. A. Ward, and the mammals obtained in the Custer expedition to the Black Hills, in 1874, the invertebrates purchased of H. T. Woodman in 1872 have been examined and labeled, and placed on exhibition. Considerable collections of plants have been made, including some fungi; about a hundred species of birds have been prepared for mounting, and several hundred specimens illustrating the paleontology of the Trenton formation have been named, and await the construction of cases for exhibition. At the close of the Centennial exhibition at Philadelphia eight boxes of ores and minerals were obtained from the various exhibits, mostly by donation, and have already been safely deposited in the storage room in the basement of the University, where, along with more than forty other similar boxes and cases, they also await the construction of other cases for their exhibition. In addition to these a purchase was made at Hoboken, N. J., of a fine general collection of mineral species, with many duplicates, especially intended to illustrate mineralogy. These consist very largely of crystalline forms. This collection, costing $400, will comprise at least forty boxes in excess of those already mentioned. For full details in respect to the Museum the reader is referred to the report on the Museum.


MAP OF
MINNESOTA.
Showing Locations of the Counties.
Total area 83,531 Square miles.
BRITISH POSSESSIONS
PEMBINA
POLK
BELTRAMI
ITASCA
LAKE
ST. LOUIS
CLAY
BECKER
CASS
WADENA
CARLTON
AITKEN
CROW WING
MILLE LACS
KANABEC
PINE
WILKIN
OTTER TAIL
TODD
MORRISON
GRANT
DOUGLAS
TRAVERSE
STEVENS
POPE
STEARNS
BENTON
ISANTI
SHERBURNE
ANOKA
BIG STONE
SWIFT
WRIGHT
LAC QUI PARLE
CHIPPEWA
KANDIYOHI
MEEKER
McLEOD
CARVER
YELLOW MED.
RENVILLE
SIBLEY
SCOTT
DAKOTA
LINCOLN
LYON
REDWOOD
BROWN
NICOLLET
LESUEUR
RICE
GOODHUE
WABASHA
PIPESTONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
DAKOTA TERRITORY
IOWA
WISCONSIN
LAKE SUPERIOR
Duluth
St. Paul
Minneapolis

astrously as they would in more sandy soils. It is only along the immediate river bluffs that any injury to the soils from this cause is noticeable. These streams furnish water power at frequent points, even more than have been improved. At some of these points the following flouring mills have been erected:

At Riceford, on Crystal creek, one custom mill, by Oatman and Co., having a power of 18 feet head. This creek issues from the rock bluffs within a few miles of Riceford, nearly all in one volume.

At Riceford Mr. V. T. Beebe also has a custom mill with 12 feet head of water.

There is a custom mill on Bear creek, near the state line, (Sec. 34, Spring Grove,) owned by Mr. Swartzhoff.

At Freeburg, on Crooked creek, is a custom mill owned by Hill and Graff, with 16 feet head of water, and a sawmill owned by Wm. Oxford. Here are also two other mill privileges.

On Winnebago creek (Sec. 22 Winnebago) is a stone mill owned by B. T. Barbour, and on Sec. 15 a custom mill owned by McMillin, Johnson & Clark.

At Sheldon, on Beaver creek, is a mill of 12 feet power, owned by John Blain, and another of the same power owned by Snyder Brothers.

J. & C. B. Howe have a saw mill on Sec. 24, Yucatan.

Nathan Vance has a flouring mill on Sec. 12, Money creek, with 12 feet fall. Fox and Perkins have another on Sec. 30, with 10 feet power, from which shipments are made by railroad.

There is a mill at Houston with 7 feet fall, in the Root river, belonging to Mr. Grorsland.

There is a shipping and custom mill SE. ¼ Sec. 23, Houston, with 20 feet power, owned by G. W. McSpadden.

At Brownsville are two mills, one by Shaller Bros. of 2 run of stone, and 12 feet power, for shipping flour, and the other by J. Hankey, of 5 feet power and one run, for custom.

At Hokah all the mills ship flour. One is owned by C. Fischer, situated on Thompson creek, and has 24 feet of water fall; another by White and Brothers, and a third by E. Thompson. The last two have a fall of 9 feet in Root river. At Hokah the Railroad Machine Shops, and the Plow Factory also run by water power.

There is also a mill on Pine creek, near the county line (Sec. 3 La Crescent,) with 4 run of stone, and 13 feet fall, owned by Graff & Co., for custom and shipping; and another on the same creek, S. W. ¼ Sec 9, by J. D. Cameron, having 9 feet fall and 4 run of stone, for shipping.

The Toledo Woolen Mill, by Fletcher and Webster, S. W. ¼ Sec. 5, La Crescent, on Pine creek, has 7 feet power. This is built of stone quarried near.

### *Surface Features.*

The topography of Houston county is very similar to that of the eastern, and particularly that of the northeastern part of Fillmore county. Taken altogether it is produced by the same causes. The strata cover the same geological horizons, at least the same as the non-drift-covered portions of Fillmore county. It varies from undulating to rough and hilly. The surface of the rock was gorged by numerous canons, each with its tributary gorges, prior to the spreading of the loam. These gorges are not so narrow as in much of the western and central parts of Fillmore county, but are of the same character as those in the Shakopee and St. Croix areas—broader and smoother, allowing the loam, when deposited, to enter their deepest recesses and to spread itself evenly over the whole. While the loam itself becomes thicker and more clayey toward the Mississippi river, it has so effectually and so deeply covered the whole country that generally a rolling or undulating surface has resulted which is almost free from the peculiar sink-holes so common in the Trenton area, but is characterized by deep, wide valleys and long ridges. The bluffs that enclose the valleys are sometimes tillable, or at least turfed over from top to bottom. They are of all hights from the more shallow depression sufficient for ready drainage, to valley lines over five hundred feet deep. The whole of Root river valley, which is in the St. Croix sandstone, is over five hundred feet in depth, with limestone capping the bluffs. Some of its tributary valleys are equally deep and wide, but the smaller tributary valleys become shallow and more rocky as the gorges ascend in the Lower Magnesian—the whole system making a series of deep valleys along the river and of alternating vales and ridges at greater distance from the main valley. The county is nowhere destitute of excellent natural drainage. There are very few of the characteristic sink-holes of the Trenton, that formation having but a small superficies in the county, and that not within the reach of important drainage couses which were capable of producing the preglacial gorges. Within the Shakopee area have been seen three or four similar sink-holes, but they differ from the Trenton sink-holes in being more plainly a part of continuous ravines and in being broader in comparison to their depth.

If the valleys excavated by drainage were filled up, the county would be very nearly flat, the highest part being in the southwestern corner, in the area of the Trenton limestone. The great diversity of surface that appears arises entirely from the effect of erosion by streams and atmospheric forces, on the rocks, which consist of alternating sandstones and limestones. This effect would be still greater, or rather would be still more apparent, were it not that the loess loam, which is very thick in this part of the state, tones down, with its overspreading canopy, the roughness which the rocky surface really possesses, leaving it actually one of an undulating or rolling character except along the immediate river bluffs, where the rocks frequently appear in craggy bluffs and cause precipitous or steep hillsides. The valleys excavated by the streams are remarkable and instructive. Not only have the larger streams cut out gorges of enormous depth in the rocky floors on which they run, but every little creek and tributary runs in a gorge which shows the same rock-sculpture. Even the freshet creeks, and the rivulets born after every summer shower, dry entirely the greater part of the year, find their way to the main valleys through rock-bound, canon-like valleys. This makes the county present the usual characters of southern latitudes where the northern drift sheet has not been spread. There is nothing more evident than that these valleys antedate to the great ice age. In other portions of the northwest where the drift does prevail, larger streams than those found in Houston county have generally worn their channels only through the drift sheet. The Mississippi river itself, above the Falls of St. Anthony, has no rocky bluffs. It very rarely even strikes the rock. It is occupied still in dissolving and removing the materials of the drift which covers that portion of the state. It would require a great many interglacial periods, or pre-glacial periods, to excavate it as deeply as the same valley is wrought in the southeastern portion of the state. In the limestone areas the valleys are narrow and more generally rock-bound; they widen out so as to inclose good farm lands on the bottoms in the sandstone areas. This distinction, however, is less evident than in Fillmore county, where the St. Peter sandstone plays a more important part in bringing about the present topography. It is, however, well illustrated in the upper portion of many of the tributaries of Root river. In descending one of these valleys from the upland the first descent is very rocky and very impracticable. This is caused at first by the cut through the Shakopee limestone. The Jordan sandstone that underlies the Shakopee sometimes relieves this ruggedness a little, but its thickness is so small compared to

that of the whole Lower Magnesian that it is barely observable in this way. Through the underlying St. Lawrence limestone the descent is also rough and the valley narrow, with little or no arable land in the valley. On reaching the horizon of the top of the St. Croix sandstone the change introduced into the aspect of the valley is very noticeable. It widens, the rock is seen exposed in a nearly continuous escarpment along the tops of the now more distant bluffs, the descent is easy, the stream flows with a winding course, and is perhaps fringed with a small shrubby growth, the lower slopes of the bluffs on either side are turf-covered, and finally a rich alluvial soil, spreading out over the bottoms shows here and there a spot that has been cleared and cultivated. This character then extends to, and follows, the whole course of Root river to its mouth, the valley constantly increasing in width, and showing a terraced condition, where ancient floods or periods of high water have stood, and whence, after vast accumulations of alluvium, have retired, reducing the river at last to its present insignificant dimensions. This is the general character of the valleys tributary to Root river, but this succession of changes can be seen within Houston county only in those tributary valleys on the south side of Root river. Those on the north side enter on the St. Croix sandstone before reaching Houston county. The best agricultural portion of the county is in the center and south-west quarter. The valleys throughout the county are generally wooded, and in the eastern part of the county a great deal of the upland is also wooded. Taken altogether the county may be denominated rolling, broken and hilly, though there are also some fine prairies that are simply undulating. All the farms are well drained naturally.

The following measurements by aneroid will show the depth of some of the valleys below the immediate upland at the points named.

Sec. 17, Caledonia, 3 miles south of Sheldon. Beaver creek, at the great spring, is 230 feet below the tops of the bluffs, which embrace the Shakopee limestone, Jordan sandstone and a part of the St. Lawrence limestone.

At Sheldon the bluffs are 420 feet high.

At Houston the bluffs north of the city are 520 feet above the level of water in Root river in summer.

At Hokah Mt. Tom rises 530 feet above the flood plain of Root river.

On Sec. 11, Union, the ridge between Thompson's creek and

the railroad, at the sculptured rock, rises 355 feet above the highway directly south of the ridge.

At Brownsville the hight of the bluff above the flood plain of the Mississippi is 495 feet. Mr. Fred. Gluck, of Brownsville, measured the same by triangulation in the winter season, and obtained 486 feet as the hight above the ice. Railroad surveyors are said to have obtained 483 feet as the hight of the same bluff. The most of this hight is made up of sandstone, there being but 105 feet of limestone in the upper part of the bluff, belonging to the St. Lawrence formation.

*Elevations on the Caledonia and Mississippi Railroad.*

This road runs from the Mississippi river westward 14¼ miles up the valley of Crooked creek. It is graded, but not yet furnished with track. These levels were furnished by Mr. Till, engineer of the road. The datum is the level of the track of the C. D. & M. R. R., just north of Crooked creek, Sec. 35, Town 102 N., Range 1 W.:

| | |
|---|---|
| Datum | 0. |
| Freeburg | 21.92 |
| Water at Oxford's dam, Freeburg | 42.95 |
| Crossing of Crooked creek at Sec. 36, 102 N., R. 1 W. (Powlesland's) bottom | 56.32 |
| Crossing of Crooked creek at Sec. 36, 102 N., R. 1 W. (Powlesland's) grade | 65.32 |
| Crossing of Crooked creek, SE. ¼ Sec. 26, 102 N., 2 W., below the junction of S. Fork—bottom | 76.74 |
| Crossing of Crooked creek, SE. ¼, Sec. 26, 102 N., 2 W., below the junction of S. Fork—grade | 86.74 |
| Surface of water at crossing of Crooked creek, NE. ¼ Sec. 22, Mayville | 152.13 |
| Bottom of creek at crossing of Crooked creek, NE. ¼ Sec. 22, Mayville | 151.85 |
| Bottom of creek at second crossing below John Molitor's, Sec. 16, Mayville | 236.70 |
| Grade at second crossing below John Molitor's, Sec. 16, Mayville | 244.87 |
| Bottom of creek at first crossing below John Molitor's, Sec. 16, Mayville | 250.77 |
| Grade at first crossing below John Molitor's, Sec. 16, Mayville | 256.72 |
| Dorsh's quarry, Sec. 17, Mayville, grade | 333.10 |
| Natural surface at the Methodist church, Caledonia | 551.18 |
| Summit, Natural surface; NE. ¼ Sec. 13, Caledonia | 571.57 |

*Elevations on the Houston, Hesper and Southwestern Railroad. (Proposed.)*

This line runs from Houston, on the Root river, where it intersects with the Southern Minnesota Railroad, southwestwardly, ascending the valley of Beaver creek, through Sheldon, Caledonia and Spring Grove townships. The following data were furnished by Dr. F. Worth, president of the conpany. The datum point was at Houston, on the grade of the S, M. R. R. where it crosses the line between sections 33 and 34, seven hundred and eleven feet above the ocean :

| | Sections. | Above Houston. | Above the Ocean. |
|---|---|---|---|
| | | Feet. | Feet. |
| Crossing township line between .... .... | 4 and 9 | 6 | 717 |
| Crossing section line between............ | 8 and 9 | 7 | 718 |
| Crossing section line between............ | 7 and 8 | 7 | 718 |
| Crossing section line between............ | 7 and 18 | 9 | 720 |
| Crossing section line between ........... | 18 and 19 | 23 | 734 |
| Crossing section line between............ | 19 and 30 | 29 | 740 |
| Crossing section line between............ | 30 and 31 | 49 | 760 |
| Sheldon village plat on section 31......... | .......... | 79 | 790 |
| Crossing section line between............ | 31 and 32 | 76 | 787 |
| Crossing section line between............ | 32 and 5 | 82 | 794 |
| Crossing section line between............ | 5 and 6 | 87 | 799 |
| Crossing section line between............ | 6 and 7 | 109 | 820 |
| Crossing section line between............ | 7 and 12 | 118 | 829 |
| Crossing section line between............ | 12 and 13 | 119 | 830 |
| Crossing section line between............ | 13 and 24 | 167 | 878 |
| Crossing section line between............ | 24 and 25 | 248 | 862 |
| Crossing section line between............ | 25 and 26 | 269 | 883 |
| Crossing section line between............ | 26 and 35 | 331 | 1,042 |
| Crossing section line between............ | 35 and 34 | 384 | 1,095 |
| Crossing section line between............ | 34 and 3 | 395 | 1,106 |
| Crossing section line between............ | 3 and 4 | 422 | 1,133 |
| Crossing section line between............ | 4 and 9 | 428 | 1,139 |
| Crossing section line between............ | 9 and 8 | 457 | 1,168 |
| Crossing section line between............ | 8 and 17 | 494 | 1,205 |
| Crossing section line between............ | 17 and 20 | 500 | 1,211 |
| On section 17, highest point............... | .......... | 524 | 1,235 |
| Crossing lines between sections.......... | 20 and 19 | 456 | 1,167 |
| Crossing lines between sections.......... | 19 and 30 | 462 | 1,173 |
| Crossing lines between sections.......... | 30 and 25 | 476 | 1,187 |
| Line between Houston and Fillmore Co... | .......... | 562 | 1,273 |
| Crossing section line between............ | 25 and 26 | 437 | 1,148 |
| Crossing section line between............ | 26 and 35 | 442 | 1,153 |
| State line west of center of Sec. 35, Newburg Township.......................... | .......... | 465 | 1,176 |

*Notes on the Plats of the United States Survey in Houston County, on record in the Register's Office at Caledonia. (The county was surveyed in* 1852–3–4.)

*T.* 101 *N.*, 3 *W.—Fractional; East part of Jefferson.*

This is embraced wholly within the river bottoms of the Mississippi. It is timbered but low, with some marsh and standing water. Mag. Var. 8° 15' to 8° 50'. Acreage, 3,169.76.

*T.* 101 *N.*, 4 *W. West part of Jefferson and South part of Crooked Creek.*

The Mississippi bluffs run north and south across the east end of this town, which embraces some marsh and slough land in the eastern tier of sections. These bluffs, which unite with those of Winnebago creek from the west, in the southeastern corner of the town, introduce in that portion a very rough and rocky character of surface. The town is nearly covered with timber. Mag. Var 7° 36' to 8° 45'. Acreage, 22,546.52.

*T.* 101 *N.*, 5 *W. Winnebago.*

This is crossed by Winnebago creek, which receives several tributaries from the north and from the south. There is a tract of prairie in the southwest corner of the town, and another in the northwest corner. The remainder is either timbered or shrubby with oaks and aspens. The creek valley is deep and rocky. Mag. Var. 8° to 8° 52'. Area, 23,045.05 acres.

*T.* 101 *N.*, 6 *W. Willmington.*

This town is about equally divided between prairie and timber, which are irregularly intermingled. Waterloo creek, in Secs. 29, 32 and 33, runs in a deep valley, with steep and rocky banks. Mag. Var. 5° 49' to 8° 31'. Area, 23,037.13 acres.

*T.* 101 *N.*, 7 *W. Spring Grove.*

Along the northwest edge of this town the South Fork of Root river causes a deep valley, which is rough, timbered, and rocky. The rest of the town is variously overspread with mingled prairie and timber or oak bushes, with gently undulating and sometimes rolling surface. Mag. Var. 5° 3' to 9° 5'. Area, 23,045.12 acres.

*T.* 102 *N.*, 4 *W.* *Crooked Creek and South part of Brownsville.*

This town is named from the creek which crosses it from west to east, south of the center. This creek, with its branches, causes a rough and rocky surface, with deep gorges over a considerable area. The town has no natural prairie. Mag. Var. 7° 35' to 8° 45'. Area, 20,403.73 acres.

*T.* 102 *N.*, 5 *W.* *Mayville and West part of Crooked Creek.*

In the central portion of this town are the sources of Crooked creek, which leaves the town toward the southeast, in Sec. 25. With the exception of small portions of Secs. 31 and 32, this town has no prairie, but the heaviest timber is along the creek and its tributaries. The surface is undulating to rough. Mag. Var. 6° 57' to 8° 30.' Area, 22,976.20 acres.

*T.* 102 *N.*, 6 *W.* *Caledonia.*

Beaver creek is the only stream in this town. It causes a rough and bluffy surface in Secs. 19, 18, 7, 6, 5, 8 and 17, flowing northward. A little more than one half is of prairie, the timber being along the creek and in the eastern side of the town. Mag. Var. 6° 13' to 9° 35'. Area, 23,063.95 acres.

*T.* 102, *R.* 7 *W.* *Black Hammer.*

The south fork of Root river crosses the western portion of this town in a northerly direction, accompanied by a heavily timbered and rocky tract affecting nearly one-half of the town. There is an irregular strip of prairie which enters the town from the southeast and runs northwest past the center. Mag. Var. 5° 24' to 8° 15'. Area, 23,042.34 acres.

*T.* 103 *N.*, 4 *W.* *North part of Brownsville and South part of Hokah.*

This is a border town along the Mississippi, and in the north has some bottom land east of the bluffs. In the southern portion the river approaches near the bluffs. No prairie is shown. The Wild Cat creek joins the Mississippi at Brownsville, Sec. 26, and Thompson creek flows across the northwest corner. These streams, like others in the county, run in deep, rocky valleys, and cause a

great diversity of surface some distance on either side from the immediate valley. They have a great many tributary valleys which do not contain streams, but which are equally deep and bluffy. Mag. Var. 7° 35' to 9° 1'. Area, 20,912.18 acres.

*T.* 103 *N.*, 5 *W.* *Union and South part of Mound Prairie.*

Root river, with its tributaries, the Crystal, Bear, and Thompson creeks, causes a rolling, and even a rough, surface over much of this town, with frequent rock exposure. There is a small area of prairie covering Sec. 4, with adjoining parts of 5, 8, 9 and 3; but the greater part of the town is represented as timbered, or overgrown with small oaks and aspens, and with hazel. Mag. Var. 6° 39' to 8° 51'. Area, 22,951.16 acres.

*T.* 103 *N.*, 6 *West.* *Sheldon and South part of Houston.*

The South Fork of Root river, with its tributaries from the south, Beaver, Crystal and Badger creeks, covers this town with a network of deep valleys, in many places very rough. In the eastern portion of the town the surface is more uniform and open. Mag. Var. 6° 39' to 8° 54', Area, 22,854.31 acres.

*T.* 103 *N.*, 7 *W.* *South part of Yucatan.*

The South Fork of Root river crosses the southeastern quarter of this town. The whole town is rough and wooded, except a narrow prairie belt occupying the river bottoms. Mag. Var. 6° 35' to 9° 15'. Area, 23,045.67 acres.

*Town* 104 *N.*, 4 *W.* *North part of Hokah, and East part of La Crescent.*

This is a Mississippi river town, and between the line of the river bluffs and the channel of the river is a belt of bottom land, much of it marshy, from two to four miles wide. The Root river cuts a deep gorge across the southern part of the town, and Pine creek crosses the northern portion. Mag. Var. 7° 45' to 8° 58'. Area, 20,398.03 acres.

*T.* 104 *N.*, 5 *W.* *Prairie Mound and West part of La Crescent.*

This town is crossed by Root river, along the southern two tiers

of sections. It has a belt of prairie within the rocky bluffs, covering Secs. 33, 34 and 35, and a marsh in Secs. 30 and 31, but the rest is more or less wooded. Pine creek also crosses the northeastern portion of the town. Mag. Var. 7° 45' to 8° 49'. Area, 23,045.07 acres.

*T. 104 N., 6 W. Houston and East part of Money Creek.*

This town is broken by Root river and Money creek. It also has Silver creek in the eastern portion. There is a belt of prairie land along the south side of Root river, within the rock bluffs, and in the western portion of the town in Money creek valley, but the most of its area is wooded and broken. Area, 22,984.56 acres.

*T. 104 N., 7 W. North part of Yucatan and West part of Money Creek.*

This town has prairie bottom-land along Root river, which crosses it from W. to E. in the southern half, and along Money creek in Secs. 1, 2 and 12. The rest of the town is more or less wooded, with a rolling surface Mag. Var. 7° to 8°. 45'. Area, 23,179.03 acres.

*The Soil and Timber of Houston county.*

The soil of the county is formed by the loess loam. It is very fertile, and apparently very enduring. It is mainly a clayey deposit, without stones or gravel, but yet in some places becomes arenaceous, the sand grains being very fine. The loess is hardly pervious to water. In the scarcity and costliness of common wells, many farmers resort to the expedient of retaining the surface water, after rains, in open reservoirs produced by throwing a low dam across some of the shallow drainage valleys that intersect their farms, thus forming with the common loam a small pool or lake for the use of their stock. Except on the brows of the bluffs which inclose the valleys this loam is thick enough to make a reliable subsoil as well as surface soil. In some of the valleys it is very thick, but here it is apt to be influenced by the causes that produced the river terraces and to mingle with the ordinary alluvium. On the uplands generally where it may not have been reduced by wash, its average thickness might reach 30 feet, but in some of the valleys material of the same aspect is sometimes encountered to the depth of over one hundred feet.

In the valley of Root river, and also along the Mississippi, the soil of the alluvial terraces, greatly resembling that of the loam in the uplands, is apt to be more sandy, and sometimes becomes very light and very poor. These materials are generally seen to be in obliquely stratified layers, and to embrace, in the Mississippi valley, small gravel stones of northern origin. The immediate flood plain of these rivers presents still another variety of soil. While it is generally sandy, and often very light, it is also a very rich soil, and is apt to be enduring by reason of the Nile-like overflows to which it is subjected, and the decomposition of large quantities of vegetation. This variety of soil sustains some of the heaviest forests to be found in the county.

The county is supplied with plenty of timber for fuel, and with some that is useful for lumber. The following list comprises a nearly, if not quite, complete catalogue of the trees and shrubby plants of the county:

Quercus rubra. *L.* (?) (Red Oak.)
Quercus macrocarpa. *Michx.* (Burr Oak.)

[These two oaks are common in the uplands. As brush and small trees they often form thickets. There are also trees of the black oak, or what are accepted as black oak by the farmers, and it may be that only the black and bur oaks exist in the county. Although considerable time has been spent in the attempt to identify this oak, mentioned in former county reports as *Q. rubra*, with doubt, it is still unsettled. There seem to be two species in some places, but in others the characters are blended in one. There is a plain popular distinction between the red and the black oak, and solitary trees of the latter are often seen of large size standing in the midst of brush, belonging apparently to a former forest growth now destroyed, while the former is very abundant as small trees or underbrush, often presenting some of the popular characteristics of the latter.]

Quercus alba, *L.* (White oak.)
Populus tremuloides, *Michx.* (Aspen.)
Populus grandidentata, *Michx.* (Great-toothed poplar.)
Populus monilifera, *Ait.* (Cottonwood.)

[Of these poplars, the first two are by far the most common, but in proportion to their numbers make fewer large trees than the last. They rarely exceed six or eight inches in diameter, while the cottonwood sometimes becomes two or three feet in diameter, as seen in the Root river valley at Houston. The cottonwood has a rough bark. The bark of the aspen may be distinguished from that of the great-toothed poplar at a distance by the fact that the former becomes white, or mottled with white, as the tree gets the size of three or four inches in diameter, while that of the latter maintains its greenish or dingy-yellow color.]

Populus balsamifera, *L.* (Balm of Gilead.) [Common in cultivation. There are some fine large trees of this kind at Mr. Powlesland's, Sec. 36, Crooked Creek.]

Populus dilatata, *Ait.* (Lombardy poplar.) [Only seen in cultivation.]

Acer rubrum, *L.* (Red maple.)

Acer saccharinum, *Wang.* (Sugar maple.)

Acer saccharinum, *Wang.* Var. nigrum, *Gray.* (Black Sugar-maple.) [Sometimes known as Rock Maple.]

Ulmus Americana, *L.* (*Pl. Clayt.*) *Willd.* (American Elm.)

Ulmus fulva, *Michx.* (Slippery Elm.)

[The first named elm is very common, and acquires a very large size in the bottom lands of the Root river, but the latter is comparatively rare. As with the oaks, the popular ideas of the elm do not agree with the scientific distinctions of Prof. Gray's Manual. Good observers and woodsmen insist invariably that there are three elms found commonly in the central and southern part of the state, viz., *Rock*, *Water* and *Red.* The first is easily understood to be the well known *American* or *White Elm*, the last the common *Slippery Elm*, but the second is not distinguishable by any botanical characters. It is named from the abundant discharge of water or sap, which it furnishes on being wounded or cut, especially at certain seasons of the year. In addition to these, sometimes a so-called *Swamp Elm* is insisted on. Prof. Harrington has reported the *Corky Elm* from Olmsted county, and this may be one of the elms popularly recognized. The demands of the geological work have not yet permitted the careful examination of these distinctions.]

Tilia Americana, *L.* (Basswood.)

Carya amara, *Nutt.* (Bitternut.)

Carya alba, *Nutt.* (Shag-bark hickory.)

[Of these the former furnishes the great bulk of the hoop-poles for flour barrels cut in the southern and central portions of the state, the latter being a much more rare tree. It is only in Houston county that the shag-bark hickory is known to occur generally. It is exceedingly rare in Fillmore county, and does not occur in the Big Woods.]

Juglans nigra, *L.* (Black Walnut.)

Juglans cinerea, *L.* (White Walnut or Butternut.)

[The former is comparatively rare, but the latter is one of the most common trees along valleys.]

Fraxinus Americana, *L.* (White Ash.)

Fraxinus sambucifolia, *Lam.* (Black Ash.)

[The former is often seen as a large tree, but the latter is rare, having been noted only in the timbered bottoms of the Root river at Houston.]

Prunus Americana, *Marsh.* (Wild Plum.)

Prunus Pennsylvanica, *L.* (Wild Red Cherry.)

Prunus Virginiana, *L.* (Choke Cherry.)

Prunus serotina, *Ehr.* (Black Cherry.)
Pyrus coronaria, *L.* (American Crab-apple.)
Negundo aceroides, *Mœnch.* (Box Elder.)
Crataegus coccinea, *L.* (Thorn Apple.)
Crataegus tomentosa, *L.* (Black Thorn.)
Celtis occidentalis, *L.* (Hackberry.)
Betula excelsa, *of American Authors.*, (Gray Birch.)
Betula alba. var. populifolia, *Spach.* (?) (White Birch.)

[Of these two birches the latter is quite common, but the former is rare. The outer bark of the latter is snowy white, and the tree rarely becomes larger than three or four inches in diameter, and indeed is usually less than two. It frequents rocky banks and sterile soils, being rarely seen except along a hillside, where its white small trunks make it very noticeable. The former has been seen only in moist, rich lowlands, with large timber surrounding, and is apt to grow, unless injured, to a large tree of a foot or two in diameter. It is probably the same as *B. lutea*, *Michx. f.* of Gray's revised manual. Its twigs and bark are so aromatic as to cause it to be mistaken for the black, or cherry-birch of the Middle and Eastern States, which has not yet been reported as occurring within the State of Minnesota.]

Pinus Strobus, *L.* (White Pine.)

[On Crooked creek; at La Crescent; on Bear creek ; on Winnebago and Money creeks.]

Ostrya Viginica, *Willd.* (Ironwood.)
Salix—Sp. (?) [Various species; one species becomes a large tree, as seen in the bottoms at Houston.]

Gymnocladus Canadensis, *Lam.* (Kentucky Coffee tree.)

[The Coffee tree occasionally is seen, even 18 inches in diameter, and is used for lumber. It was particularly noted about Houston.]

Larix Americana, *Michx.* (Tamarack.)

[Only known on Pine creek.]

Cornus circinata, *L'Her.* (Round-leaved Cornel.)
Cornus sericca, *L.* (Silky Cornel.)
Cornus paniculata, *L'Her.* (Panicled Cornel.)

[Along the ravines.]

Cornus alternifolia, *L.* (Alternate-leaved Cornel.]
Gaultheria procumbens, *L.* (Wintergreen.)

[Seen only at Mound Prairie.]

Alnus incana, *Willd.* (Speckled Alder.)
Diervilla trifida, *Mœnch.* (Bush Honeysuckle.)

[Along the bluffs of the Mississippi.]

Rhus typhina, *L.* (Stag-horn Sumac.)

[Rare; seen at Brownsville.]

Sambucus Canadensis, *L.* [Common Elder.]
Castanea vesca, *L.* (Chestnut.)

[Cultivated; seen on Sec. 29, Union.]

Robinia Pseudacacia, *L.* (Locust.)

[Only cultivated.]

Gleditschia monosperma, *Walt.* (Water Locust.)

[Only in cultivation; seen at Hokah.]

Rosa blanda, *Ait.* (Early Wild Rose )
Rosa Carolina, *L.* (Swamp Rose.)

[This is a bushy rose, eight feet high and less.]

Rhus glabra, *L.* (Smooth Sumac.)
Rhus Toxicodendron, *L.* (Poison Ivy.)
Abies balsamea, *Marshall.* (Balsam Fir.)

[Only in cultivation.]

Rubus strigosus, *Michx.* (Red Raspberry.)
Rubus villosus, *Ait.* (High Blackberry.)
Rubus occidentalis, *L.* (Black-cap Raspberry.)
Rubus ———(?) (Low-bush Blackberry.)

[More or less trailing.]

Juniperus Sabina, *L.* Var. procumbens, *Pursh.* (Trailing Cedar.)

[Hokah and Sheldon.]

Juniperus Virginiana, *L.* (Red Cedar.)
Apocynum androsæmifolium, *L.* (Dogbane.)
Carpinus Americana, *Michx.* (Water Beech.)
Spiræa opulifolia, *L.* (Nine-bark.)
Zanthoxylum Americanum, *Mill.* (Prickly Ash.)
Amorpha canescens, *Nutt.* (Lead Plant )
Lonicera parviflora, *Lam.* (Small honeysuckle.)
Amelanchier Canadensis, *Torr. & Gray.* (Juneberry.)
Vitis cordifolia, *Michx.* (Grape.)
Ampelopsis quinquefolia, *Michx.* (Virginia Creeper.)
Celastrus scandens, *L.* (Bittersweet.)
Clematis Virginiana, *L.* (Common Virgin's Bower.)

[Common in the valley of Root river, below Hokah.]

Viburnum Lentago, *L.* (Sheepberry.)
Viburnum Opulus, *L.* (High-bush Cranberry.)

Ceanothus Americanus, *L.* (Jersey Tea.)
Aristolochia Sipho, *L'Her.*(?) (Pipe Vine.)
Ribes Cynosbati, *L.* (Gooseberry.)
Ribes floridum, *L.* (Wild Black Currant.)
Ribes rotundifolium, *Michx.* (Gooseberry.)
Corylus Americana, *Walt.* (Hazel.)
Symphoricarpus occidentalis, *R. Br.* (Wolfberry.)
Dirca palustris, *L.* (Leather-wood.)

[This was found along the bottoms of Beaver creek, in Caledonia township, in the neighborhood of the Great Spring. The wood, instead of being "very brittle," as described by Gray, was pliable and spongy, resembling a green cornstalk. This was in the month of July.]

Smilax rotundifolia, *L.* (Common Greenbrier.)

[This was seen growing very luxuriantly in the sandy alluvium of the Root river bottoms, below Hokah, associated with the Virgin's Bower and the Climbing Bittersweet. In the same vicinity were also the wild grape, the Virginia Creeper, and a number of herbaceous vines. The leaves on the different parts of the Greenbrier differ very noticeably. Those on the large annual shoots, which run 10 or 15 feet, are ovate and heart-shaped, large, 3 inches long; those of the fruiting stems or branchlets are rarely heart-shaped, but are ovate, and less than half the size of the former. Both sorts are rough on the edges, and on the prominent ribs beneath, and are barely pointed. The Carrion Flower, *Smilax herbacea, L.*, was doubtfully identified in the ravines on the north side of the valley at Houston.]

It is noticeable that many of the valleys, particularly those running east and west, as Crooked creek valley, have the bluffs along the north side of the creek destitute, or nearly so, of timber, but are heavily timbered along the opposite bluffs, on the south side. This may be due to warm days in winter or early spring, when the sap may have started in the trees on the north bluffs, followed by severely cold weather, before the actual setting in of steady warm weather. Of course the sun's heat would be quickest felt on the bluffs facing south. This process, repeated for a good many years, would injure and at last destroy the timber on the north bluffs, if it were ever possible for trees to have come to maturity there, while timber on the south bluffs would escape these sudden changes, owing to the shaded condition of the bluffs during the warmest portion of the day, and would only experience a steady increase of warmth due to the progress of the season.

### *The Geological Structure.*

The rocks of Houston county are embraced wholly within the Lower Silurian. They are as follows:

The *Trenton limestone*, confined to the southwestern quarter.

The *St. Peter Sandstone*, in an irregular area surrounding the area of the *Trenton* above.

The *Lower Magnesian* formation, comprising the three parts, *Shakopee limestone*, *Jordan sandstone* and *St. Lawrence limestone*, and underlying the greater portion of the county.

The *St. Croix sandstone*, which is found only in the bluffs of the Mississippi and Root rivers, and of their tributary valleys.

The accompanying map of the county shows the superficial areas to which each of the foregoing formations pertains. Owing to the frequent deep valleys the geographical boundaries of the formations make very crooked and tortuous lines. Although these valleys are more or less filled with the loess loam, the topography still is so marked, pertaining to and even caused by each different formation in the county, that the outlines of the geological structure are very evident to the observer. As in Fillmore county, there is more or less doubt about the position of the boundary between the St. Peter and the Lower Magnesian. The incoherency of the St. Peter causes it to crumble easily, and to leave no evidence of its final dissolution where the exact contact between the formations cannot be examined—and the loam generally securely hides this horizon.

## *The Trenton Limestone.*

The greater portion of this formation, which is found within the county, is of the Lower Trenton, so-called, and produces the same topographical features as in Fillmore county. The reader is referred to the report of progress for 1875, where the geology of that county is given, and the effect of the Lower Trenton on the surface features is discussed and illustrated by diagrams.

This formation is found in Spring Grove and Willmington townships. It runs also in a narrow, but interrupted belt, nearly to Caledonia, where it may be distinctly seen, in its peculiar features, and its flat-topped mounds, or tables, a mile west of that village. There is reason to suppose that it formerly extended much farther east than it does now, covering the most, perhaps the whole, of the county, and being continuous with the horizon of the same formation on the east of the Mississippi river, in Wisconsin.

The usual characters of the Lower Trenton, both lithological and palæontological, were the only ones noticed in Houston county It has been opened for quarries only in the vicinity of Spring

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Grove. It generally presents a stained and long-weathered aspect, as if split and dissolved by the action of water. The layers are at first about an inch in thickness, but become thicker, by adhering to each other, on being wrought to some depth, and possess a blue color.

### *The St. Peter Sandstone.*

This lies next below the Trenton. Its area embraces not only the slope from the high table-land of the Trenton area, but also a belt extending in width from the foot of that slope over the more level country surrounding, so that its irregular area is often a mile or two in width. As already remarked, while its upper limit has a very easily recognized location, by reason of the terrace-like topography of the Lower Trenton, its lower horizon is often very uncertain on account of the very easy and gradual destruction of its layers, and the prevalence of the loess loam.

The character of this sandstone in Houston county is about the same as described in other counties, and need not be detailed again here. It was noticed, however, that for some reason it is more frequently hardened by iron, or lime and iron in Houston county, into a firm rock, which causes it to sustain a weathered exposure without crumbling rapidly away, than in counties further north or west where the northern drift prevails. This, however, is purely an accidental and surface quality, the interior of the formation being about the same as at other places. The cement which it possesses in Houston county, in its exposed portions, in excess of the same at other points, is no doubt due to the water by which it has been submerged and stained during the deposition of the loess loam.

The thickness of the St. Peter sandstone was very satisfactorily ascertained on the S. W. ¼ Sec. 17, Wilmington. The well of Mr. O. A. Bye is situated near the Trenton bluff, and by uniting the known depth drilled in the sandstone with aneroid measurement of the bluff, the St. Peter was found to be between 75 and 80 feet thick, the Shakopee below having a thickness of 64 feet.

### *The Shakopee Limestone.*

The continuity of this formation from the Minnesota valley to the Mississippi, and its identity with the limestone at Shakopee, where it was first recognized as a distinct member of the Lower Magnesian in Minnesota, was fully established in the survey of

Houston county. It is everywhere distinct as the uppermost portion of the Lower Magnesian, and is everywhere separated from the other great calcareous member of the same formation by a sandstone as distinct and continuous, and as clearly recognizable, as the St. Peter sandstone. There can be no further question of its existence and its great extent. There seems every reason to believe also that it exists across the Mississippi, in the state of Wisconsin, but at this time there is no distinct published notice of its occurrence there. The Lower Magnesian in Wisconsin has been divided by Prof. R. Irving, of the Geological Survey of Wisconsin, into three parts, as exemplified near Madison, (*American Journal of Science and Arts, June,* 1875,) but there is much reason to believe that his proposed subdivisons do not include the Shakopee limestone at all, and that the distinctions in the Lower Magnesian which he mentions are wholly confined to the St. Lawrence limestone of Minnesota. This subject was discussed by the writer in the *Bulletin of the Minnesota Academy of Natural Sciences, for* 1875, when this hypothesis was first published. It is rendered still more plausible, in the absence of further facts in Wisconsin, from the fact that even in Houston county the St. Lawrence exhibits variations of composition and lithology which are comparable to those Prof. Irving describes.

The characters of the Shakopee in Houston county are not noticeably different from those mentioned in the reports of progress for 1873 and 1875. Its bedding is much less regular than that of the St. Lawrence. It is apt, indeed, to be disturbed by cherty, or concretionary masses, which on the weathering away of the bluffs become detached and fall into the bottom of the valley, where they lie long after the non-silicious portions of the rock have dissolved and disappeared. Such cherty lumps are often a foot, or even two or three feet in diameter. They are roughened by cavities opening on the surface, by dissolution of the most calcareous parts, and by the natural openings and pores they acquired in the act of formation. They are the only portions of the formation in which fossils have been found in Houston county. These masses sometimes show surfaces of drusy quartz crystals, also amethyst crystals, and great quantities of pyrites, oxydized and hydrated so as to produce a limonite, the form of the crystal alone remaining to indicate the original mineral. A careful study of these fossils has not yet been made, but there is some evidence, from the handling to which some of them have been subjected in the examination of the Trenton fossils now going on, that the Shakopee limestone is the equivalent of the Chazy of New York, a formation which has

not been recognized in the state, though the St. Peter has been regarded by Prof. Hall as its equivalent.

This formation does not appear in the bluffs of the Mississippi river, in Houston county, nor in those of Root river generally; but its line of strike is some miles back in the country away from the immediate bluffs. This is due to the crumbling nature of the Jordan sandstone which underlies it, and which operates, in that respect, to tear down the Shakopee in the same manner, and for the same causes, as the St. Peter on the Trenton. To this fact, and to its general resemblance to the St. Lawrence limestone, may be attributed the non-discovery of this limestone by the United States geologists who have reported on the geology of the state, or by others, whose examinations were largely confined to the main water courses, before the general settlement of the state and the construction of good roads. Its area is embraced, on the colored map of the county, in that assigned to the Lower Magnesian.

This limestone may be seen frequently in the central portion of the county, in the upper reaches of the ravines which radiate in all directions from the vicinity of Caledonia. It is seldom quarried, or used for any purpose, for the St. Lawrence limestone is generally accessible in the immediate neighborhood, and that is much more desirable for building-stone, or for lime-making. In descending the ravine toward the quarries east of Caledonia the Shakopee is the first limestone seen exposed. The quarries are much lower—in the St. Lawrence. It may be seen also in the upper tributary valleys that feed Badger, Beaver, Crystal and Thompson creeks. It causes the first rugged or rocky portion of those valleys. It is exposed in the tops of the bluffs at the great spring, Sec. 17, Caledonia, three miles south of Sheldon. Its thickness at Mr. O. A. Bye's, Sec. 17, Willmington, when drilled through, was found to be 64 feet, which is probably about its average thickness throughout the county.

### *The Jordan Sandstone.*

The lithological features of this sandstone are nearly the same as those of the St Peter, but it has only about one-half the thickness of the St. Peter. Its area of outcrop is quite small, and its exposures are few. As it lies between two hard limestones, which are apt to form perpendicular, walled bluffs, its line of outcrop is known by a belt of non-exposure of rock separating the Shakopee from the St. Lawrence, which is less steep in the ascent, and perhaps turfed over. It often becomes rusty and firm from a cement

of iron, when it endures longer exposure, and is seen as detached blocks in the valleys. Some blocks of this kind are visible by the roadside in the ravine that descends to the quarries of Aikin and Molitor, a mile east of Caledonia.

### *The St. Lawrence Limestone.*

This is the most important formation in the county. It not only occupies a greater superficial area of outcrop than any other, but it takes the most prominent part in causing the varied topography of the county. It surmounts the St. Croix sandstone, an easily eroded rock, into which the valleys are deeply and rapidly cut, and maintains a bold and sharp outline along their tops. It is the immediate cause of a great many hills and ridges. It confronts the observer in every nook and on every promontory, along the whole course of the Root river, and down the Mississippi bluffs as far as the state line, and it is especially conspicuous in the little valleys that ascend from the streams, and that often are more rocky than the larger valleys.

The thickness of the St. Lawrence in Houston county is about 200 feet, though other geologists have reported it as 250 feet thick at La Crosse. It is a dolomite, or magnesian limestone. Its layers, while generally regular and useful as a building-stone, are also sometimes very much brecciated, rendering it at once more firm, but also more refractory. It furnishes more stone for building than all the other formations of the county combined. It is of a light, lively color, and endures the weather perfectly, showing not the least change in the oldest buildings in which it has been used

### *The St. Croix Sandstone.*

This name was applied, in the first annual report, provisionally to the light-colored and often friable sandstones which occur along the Mississippi river in Minnesota, and which have by some been regarded as the stratigraphical equivalent of the Potsdam sandstone of New York. This was done because, in the existence of another formation, of different lithology, affirmed also to be the equivalent of the New York Potsdam, it was necessary to have some designation for each of them. It seemed from considerations there given, that the lower of these two sandstones was the probable equivalent of that formation in New York, and in subsequent reports, while no facts have been gathered that confirmed that

view, the survey not having been carried on where these rocks are exposed, the provisional name has been continued. It is only in the county of Houston that any opportunity has been afforded for an examination of this formation, since the season of 1872.

It is not intended here to enter upon an examination of the evidences of the parallelism of this sandstone with any eastern formation, nor to cite or compare authorities one way or the other. Considerable has been written on the sandstones of the Lake Superior region as developed in Michigan, Wisconsin and Canada, tending to show the existence of two distinct sandstone formations. Prof. Irving (American Journal, 3rd Series, Vol. VIII, p. 46.) reports *three* different sandstones existing in the northwest involved in this disputed horizon, as exemplified in his study of northwestern Wisconsin, viz.: (1) Copper-bearing, highly tilted sandstones, conglomerates and shales, associated with trap. (2) Horizontal, aluminous, red sandstones, lighter than those associated with the trap, which "*appear to dip* underneath the light colored Lower Silurian sandstones of the Mississippi Valley," and (3) the light-colored sandstones of the Mississippi valley. In this he agrees with Dr. C. Rominger (Vol. I, p. 95, Palaeozoic Rocks, Geological Survey of Michigan,) who makes them—(1) Copper-bearing rocks, (2) Lower Division of the Lake Superior sandstone, and (3) the Upper Division of the Lake Superior sandstone. Brooks and Pumpelly, however, do not make mention of but two series of sandstones in the Lake Superior region, viz.: (1) The copper-bearing series, and (2) the Silurian sandstones. (Michigan Geological Survey. Vol. 1. Part I, pp. 75 and 185; and Part II. p. 1.) Foster and Whitney in 1851 referred all the sandstones in question to the Potsdam of N. Y., regarding them as deposited over an uneven surface, producing local cross-stratification and unconformability. (Report on the Geology of the Lake Superior Land District. Part II, p. 120.) In this they were seconded by Prof. James Hall, and followed by Prof. J. D. Dana in his Geological Manual, First Edition. More lately, in 1862, Prof. Hall parallelized the uppermost of these sandstones with the New York Potsdam, (16th Regents' Report, p. 119,) with the cautionary remark that "it may not yet be regarded as proved that the sandstone from which I have described these fossils is in all respects the equivalent of the Potsdam sandstone of New York, Vermont and Canada. It may represent more, or it may represent less than that formation. The *lower* accessible beds of the Mississippi valley may represent the Potsdam of one hundred and fifty or two hundred feet in thickness in the typical localities in New York,

while the middle and upper beds of the west may be of epochs not represented in that part of the series studied in New York." As long as the Potsdam sandstone at the typical localities in New York was accepted as the base of the fossiliferous primordial strata, while at the west there are two recognized sedimentary sandstones, though not yet proved fossiliferous, lying below the sandstones of the Mississippi valley, it seems quite presumptious to affirm the horizontality of the light-colored sandstones with the New York Potsdam, especially when, as admitted by Prof. Hall, "there are no species of fossils in the western sandstones which are positively identical with those of New York." It would be more in keeping with recognizing stratigraphical laws, to allow that formation which in New York begins with the top of the "azoic" to begin there also in Minnesota.

In this state of the question concerning these sandstones it seems justifiable to retain for the present the term St. Croix, inasmuch as there can then be no misunderstanding of the horizon under consideration. It is perfectly legitimate, in the further investigation of this question, for the geologists of states further east to inquire which of the sandstones lying below these beds may be the equivalent of the New York Potsdam, for it seems as if on ascertained stratigraphical evidence, as well as on lithological and palæontological facts that are undisputed, these beds occupy a much higher horizon. They seem rather to be embraced in the great calciferous or Canadian epoch.

Although these sandstone beds occupy the river bluffs along the Mississippi and the Root river throughout the county, they afford but very few opportunities for satisfactory examination. They are in the lowest part of the bluffs and are generally hid by a sloping talus that is usually turfed over. The only point at which a useful section of their composition could be had was at Hokah. The general section at this place, as nearly as it could be made out, is as follows, in descending order:

*General Section at Hokah.*

| | Feet. |
|---|---|
| St. Lawrence limestone, of the Lower Magnesian, about | 200 |
| Slope, unseen | 30 |
| Sandstone, line of constant exposure | 30 |
| Slope, rock unseen | 30 |
| Whitman's quarry, made up as follows: | |
| 1. Broken, shaly, and sandy, crumbling and fragmentary | 10 |
| 2. Shale bed, greenish, with remains of trilobites | 1 |

| | |
|---|---|
| 3. Tough, persistent layers, like an indurated, arenaceous shale, with green sand, in thin layers | 12 |
| 4. Crumbling sand, in oblique stratification | 8 |
| Rock very similar to No. 3 extends downward, covering the horizon of an old quarry east of Hokah, now abandoned as worthless, embracing a thickness, that is generally a turfed slope, of about | 150 |
| Rusty, coarsely arenaceous sandrock with Lingulepis (Lingula) | 10 |
| Crumbling, white sandrock, massive | 25 |
| Variegated, arenaceous quartzyte, purple and white, hard and persistent, level with the top of the dam | 2 |
| Massive, white sandrock | 20 |
| Total rock, about | 523 |

The hight of Mt. Tom at Hokah, by aneroid, above the flood plain, was found to be 530 feet.

At an old quarry east of Hokah, and across Thompson's creek, now abandoned because the rock is worthless for all purposes, the general aspect of the layers is much like that at Whitman's quarry, but the sand is less firmly cemented, making a stone not so good. It is a shaly and arenaceous standstone, of coarse and fine grain, marked with fucoids and abundant greensand, and is below the stratigraphical level of Whitman's. In the same bluff, about twenty-five feet higher, is a blind shoulder or terrace which is more likely to contain the layers of Whitman's quarry. This stone as taken from Whitman's quarry, although very shaly, becomes firm and enduring on exposure.

At Houston the bluffs north of the village are 520 feet in hight, and of this the lower 420 feet at least belongs to the St. Croix sandstone. They probably contain the St. Croix 20 feet further up, shown by the toppling over of huge blocks of St. Lawrence limestone, from the crumbling out of friable sandrock along the salient angles of the bluffs. The interval of the sandstone layers is mainly turfed over so as to render an inspection of their contents impossible, except at points near the top and near the bottom. There is a line of nearly constant exposure about 40 feet below the top of the St. Croix, occupying an interval of 30 or 40 feet, which is particularly noticeable along the north side of the river, and was mentioned in the report on Fillmore county. There is another exposure of these beds near the level of the river at the dam at Houston. The former consists of a hard, firm sandrock, and the latter is soft and crumbling, with cross stratification. Above the line of constant exposure, about 25 feet, is a blind terrace which occasionally reveals the rock which causes it.

It is a sandstone, and is included in the foregoing thickness of 420 feet.

At one mile north of Sheldon there is an apparent dip in the outcropping upper edge of the St. Croix, as it strikes across the bluffs. Its direction is perhaps a little west of south, and amounts to two or three degrees. It is entirely local, and the corresponding upward dip in the opposite direction is invisible. The bluffs south and north have their usual hight.* No such dip was noticed in any other part of Houston county, but it is very likely this is on the strike of the noticeable dip in these formations which has been mentioned by Dr. Owen and by the geologists of Iowa as occurring in the bluffs of the Mississippi river at McGregor and Lansing, in the State of Iowa.

In Caledonia township, Sec. 2, the following section was taken:

*Section covering the junction between the St. Croix and the St. Lawrence.*

| | Feet. |
|---|---|
| Slope, covered with large blocks of limestone | 200–300 |
| Even layers of limestone quarried | 12 |
| Hid. Mainly limestone, like the next | 40 |
| Limestone, broken and curling bedding. Cherty, arenaceous or massive with some green sand | 25 |
| Lime and sand, lumpy with irregular concretions, mainly massive | 15–20 |
| Soft sand, with cemented or quartzitic lenticular lumps | 10 |
| Soft, massive sand. (Causes the blind terrace at Houston) | 25 |

The line of constant exposure mentioned as occurring at Houston, near the top of the St. Croix sandstone, lies below this section. This line is more evident in the north than on the south bluffs—due, probably, to the erosive action of the prevailing winds, which are from the southwest, and to the greater scarcity of timber on the north bluffs, as already noted under the head of *Soil and Timber.*

The fossils that have been gathered from this formation consist very largely of trilobite remains. They will be examined as opportunity may be afforded in the future progress of the survey.

On Sec. 11, Union township, the sandstone which has been mentioned as having a nearly constant line of exposure, is sculptured, along the north bluffs, into isolated columns and tables, with some rounded buttresses which present a very conspicuous and highly interesting instance of atmospheric erosion. There

* Compare *Geology of Iowa, Hall & Whitney*, 1858, *Part II, p.* 61.

can be no doubt that the bluffs themselves are the result of the erosion of the valley by water by a process that began thousands of years before the glacial epoch, but the present condition of most of the curious forms, like that of the "sculptured bluffs," is certainly due to the effect of wind in conjunction with moisture and frost. There are also cavities and sheltered nooks, and deep, crooked passages and sharp niches in which the wind could barely enter, and from which there could not have been any wind exit sufficient to have maintained a current capable of producing the most of this sculpture, which, moreover, are lichen-covered, and bear an aspect of age and roughness that forbids their reference to any present atmospheric forces. These can be explained only by the solvent action of water in agitation, and are comparable to the purgatories that are often seen about the rocky shores of lakes or of the ocean. But when the rock shows a recent, fresh erosion, and is soft and crumbling, the present forms are due to more recent causes, and can only be assigned to wind and frost.

### *The Drift.*

The true northern drift is not spread over this county. It contains no drift clay, nor boulders of foreign origin. There is a thin deposit of foreign gravel at Riceford, in the extreme southwestern part of the county, and there is a terrace along the Mississippi river that is made up of gravel and sand of northern origin, but this county wholly escaped the operation of those forces which spread the well-known drift clay and boulders over the most of the state. Whether any former glacial era caused it to be covered with the ice of the northern glaciers cannot be determined, since the materials left by that era, if any there were, may have been decomposed, and may have entered into the stratified clays and the soils of the Mississippi valley further south under the combined influence of time, and the intense activity of the destructive forces of the latest glacial era.

There is to be seen occasionally a local drift, or debris, derived from the rock of the country round about, and this sometimes has a deceitful resemblance to true northern drift, yet it can always be distinguished from it on examination. On the northwest quarter of section 25, Caledonia, along the road, near the brow of the Shakopee limestone, there is a bank of such loose materials. There is a cut of about three feet, which consists mainly of rusty loam, rather sandy, embracing large masses of black quartzite, which also vary to a lighter color but show very little, if any, lime.

Other lumps consist of pyrite crystals, now converted to limonite, and of rusty, hardened sandstone, perhaps from the St. Peter. These last, indeed, comprise perhaps a majority of the stony masses. There are also large quantities of ordinary chert, and an occasional piece of water-worn limestone. The bank shows no stratification, but consists of these materials simply mingled with the loam. The whole appears red and rusty, but discloses not a single piece but can be referred to the Lower Magnesian formation.

As to the cause of this exemption of a part of southwestern Minnesota, and portions of Wisconsin, Iowa and Illinois adjacent, from the forces of the northern drift epoch, there has been but one opinion advanced, so far as the writer is aware. It is that of Prof. J. D. Whitney, who attributes it to the *non-submergence of this region since the deposit of the Silurian rocks and their elevation above the ocean.* If it were demonstrated or generally believed that the prevalence of the drift in other parts of the Northwest, in the same latitude, is due to the submergence of the continent beneath the ocean since the Tertiary age, this assumed cause would be apropos. But on the contrary it is pretty generally agreed by geologists, both in America and Europe, that the drift is due to the former existence of glaciers that covered the surface of the country, and, moving generally southward, not only brought from the northern regions the foreign substances that constitute the drift, but required, for their existence, that the land surface should be raised several hundred feet at least above the ocean during their prevalence.* Again there is every reason to suppose this region *has been submerged* since the age of the Silurian. It is difficult to conceive what could have produced the horizontal lamination of the loess loam, unless it be attributed to the action of standing, or but slightly agitated water. This loam not only exists along the immediate river valley, but is spread widely over the highlands of the whole district. It is true there is no evidence of its having been the product of marine depositions, on the contrary it is evidently of fresh water origin ; but that the country has been deeply submerged and remained so for a long period within recent geological time can hardly be questioned. There is also reason to believe that some portions of it were buried beneath the waters of the Cretaceous ocean.

In the light of the more recent investigations of geologists it is safe to take for granted the following conclusions respecting the drift, so far as they bear on this question.

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*Those interested in this subject will find it exhaustively treated in James Geikie's *Great Ice Age, and its relation to the antiquity of Man.* Second Edition, 1877.

1st. That the earth suffers such changes of climate that, after the lapse of long periods, the temperate latitudes become frigid, and are covered with continental ice-fields or glaciers, which have a slow movement southward.

2d. That between these periods conditions of more genial climate prevail, when vegetation and animal life return slowly to inhabit the countries from which they had been driven by the rigors of the previous cold.

3d. That the severity of the cold during the successive glacial epochs is not always the same; but that the ice-fields are more extensive during some than during others.

These continental ice-fields, while conforming in general to the laws and conditions of a solid, yet exhibited, as glaciers do now, many of the characteristics of a plastic body, warped and moved by the force of gravity, and hence exemplified many of the principles of running water. The tendency for them was to seek the low lands and to avoid the natural obstructions presented by mountains or by hills.

In examining the topography and the geological structure of the country lying to the north of this so-called driftless tract, it is evident that the great valley of the Lake Superior region, once occupied by glacial ice, would overflow, both first and last, along the lines of the lowest outlet, and that perhaps the higher and less passable parts along its southern barrier-shore would never be entirely surmounted. The continental glacier, in this region, would flow toward the southwest or south, guided by the main topographical features. In north-central Wisconsin is an isolated area of granitic and metamorphic rock, which not only extends to the shore of Lake Superior, but wedges out northeastwardly in the form of a long, high and persistent point or spur, in the southern part of Lake Superior, known as Kewenaw Point, in the State of Michigan. It is plain to see that this point would act on a crowding but somewhat flexible mass of ice as an entering wedge to split it into two main masses, and that the widening of the wedge, in the granitic region of northern Wisconsin, would perpetuate the division so as to cause, if other topography were favorable, a constant flow along the northwest side, and another in a more southerly direction, that would spread over northern Michigan and find its easiest exit through the valleys of lakes Michigan and Huron. According to Prof. R. Irving, and Messrs. Foster & Whitney,* the western end of Lake Superior lies in an Archaean synclinal trough

*American Journal of Science, 3d Series, Vol. VIII, p. 54. Report on the Geology of the Lake Superior Land District.

running southwesterly. This again would divert the flowing ice over the northeastern portions of Minnesota to the expense of northern Wisconsin. Glacial scratches on the rocks at Duluth, at the western extremity of the lake, have a west-southwesterly direction.

Now it is a striking coincidence that this driftless tract lies nearly south and in the lee of this wedge-like area of metamorphic rock, and would be protected from the ice-flow by it. It is hence reasonable to infer that the absence of the drift in this region is due to the existence of this protecting barrier lying to the north of it in Wisconsin, while further to the south the two main branches of the ice-flow again united and spread, before their final retirement, a continuous sheet of drift over central Illinois, and southern Iowa.

It is very evident, from the fact that the remains of an older drift sheet are found under the loam in some of the western parts of this tract, (see report on Fillmore county,) while the latest drift sheet does not spread so far nor so wide, that the last period of cold was far less intense than some former one had been. This last drift sheet is spread over the ancient soil, containing vegetation in a nearly continuous layer, the remains of a forest which flourished between the two glacial periods, along the margin of the last ice-field. This belt, characterized by buried soils and wood, crosses Fillmore and Olmsted counties, and it is probably true that wherever such remains are found, in a flat country like southern Minnesota, lying under glacial drift, they mark the point where glacier ice ceased to act powerfully enough to disrupt the old soils. Such ancient soils may have existed on the top of older glacial drift, or on any other surface. It is probable that it was during the prevalence of the last glacial period, or just as the ice began to recede so as to produce copious waters, that the loess loam of the Mississippi valley was deposited over this region, and that at the same time the waters of the Minnesota were augmented by the drainage of the entire Winnepeg and Red river valleys through its channel, some of them at first reaching the Mississippi through the Cannon and the Vermillion river valleys. At first these waters spread irregularly and widely, fluctuating with the seasons, so as to leave no recognizable beach lines ; but at length when the most of the state had been left by the retreating glacier, they became more uniform in their volume and were confined to the actual river gorge. They seem to have maintained, for a long period, a pretty uniform stage at this point, for when, on the drainage of the Winnepeg basin toward the north, consequent on the final retreat of the ice beyond

the mouth of the Nelson river, in British America, the Minnesota was reduced to about its present dimensions, a high terrace was left along the Mississippi, through all this driftless region and also further south. The high water in the Mississippi ascended the gorges of the tributary streams, retarding their flow and causing similar terraces along their lower reaches.

[NOTE.—In the report for 1875 it was stated (page 66) that no drift-clay like that which covers the western part of Fillmore county had been seen overlain by the loess-loam, except that which pertains to the general drift sheet of the northwest, where the loam overlaps the later drift. In passing through Fillmore county in 1876, the remains of this ancient drift sheet were seen at numerous places between Sec. 4, Canton, and Lenora. At one point it is a light-colored, or ashen, gravelly clay which above is very irony or rusty. Over the surface are numerous fragments of chert with some small boulders of granite, and greenstone, and jasper and quartzite pebbles. This is the first satisfactory identification of the *old* gravelly clay within the loam-covered area, or driftless tract. It is covered with several feet of loam. It is seen similarly NE. ¼, Sec. 12, Canton.]

### *Alluvial Terraces.*

There is a marked alluvial terrace that accompanies the Mississippi and Root rivers, and ascends their lower tributaries, but it does not seem to be true that all the streams are terraced before reaching the level of this terrace. This indicates that the high water which produced that terrace was due to backing up from the Mississippi, and that possibly the country itself in general was not more wet than it is at present; in other words, that the amount of surface drainage that passed down the valleys was no greater than now. Root river was simply wider and deeper, with a sluggish current, due to the greater volume of the Mississippi. The highest point at which the terraced condition of Root river has been observed is Preston, in Fillmore county, but it must certainly extend several miles further up that valley. By aneroid measurements, united with levels of the S. M. R. R., the hight of this terrace at Preston is found to be about 300 feet above the Grand Crossing of the S. M. R. R. near the mouth of Root river, while the same terrace at Hokah, likewise near the mouth of Root river, is only about 100 feet above the flood plain. It is also probable that the loam terrace, as seen at La Crescent, is the same continued to and coalescent with the Mississippi terrace; and there it is 90 feet above the Mississippi flood plain. This would necessitate a fall of about 200 feet in the Root river at its highest stage, in a dis-

tance of 50 miles in a right line. If this fall can be explained consistently with the assumed back-water condition of the Root river, at that time, it will further confirm the hypothesis that the Mississippi then drained the Red River and Winnipeg regions, receiving their waters from the Minnesota. It seems further that this explanation is necessary to the maintenance of that hypothesis; for if Root river was maintained at that high level by the demands of its own drainage area, then much more the Mississippi could also have been kept there without the aid of the Winnipeg waters. Root river valley, between the rock-bluffs, has an average width, through Houston county, of about two miles, and that would have been the width of the stream, with a depth of over one hundred feet.

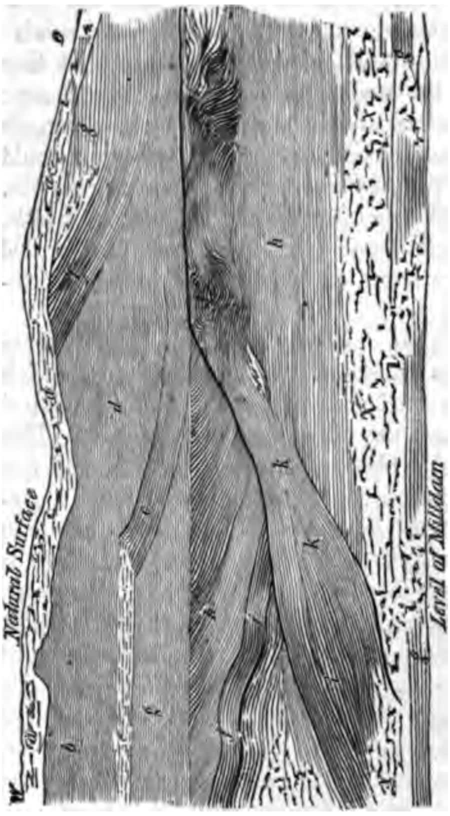
There is, besides this high, loam-terrace, a second terrace level, visible specially at La Crescent, on the Mississippi, which there rises 50 feet above the flood plain of the river and spreads out in a pleasant plateau on which the village has been located. This terrace is made of gravel and pebbles of northern origin, and was identified only along the Mississippi. The largest stones it contains are about 3 in. in longest diameter. It is passed through in wells, and seems to be entirely pervious to water, as all wells on it get water at about the level of the flood plain of the river. This material is used for grading, and road-bed, on the C. D. & M. R. R., and elsewhere. It consists entirely of rounded waterworn materials, the main part being the usual parti-colored quartzite pebbles, granitic, hornblendic, amyglaloidal, and lamellar, as well as uniform and massive. A great many of them have a red color, or some shade varying from red. The coarsest pieces are rare, found only in the upper portions of the *debris* of alluvial fans.

The following more special observations were made on these terraces in Houston county. At Sheldon, six miles from Root river, in the valley of Beaver creek, the terrace on which the Newberry House stands is 30 feet above the water of the creek below the dam. The materials of the terrace at this place are sandy loam horizontally stratified, with more clay near the top, and less evident stratification.

At Houston the only observable terrace, measured about a mile west of the city, is 65 feet above the flood plain. The track of the R. R., is about one foot above the flood plain of the river, which is 18 feet higher than the water below the mill-dam.

At Money creek the terrace rises 30 feet above the flood plain which is 20 feet above low water below the mill-dam. The contents of the terrace are stratified. On Sec. 30 in this town the

contents of the Root river terrace, and their arrangement, are shown by the following sketch which was taken on the spot:




*Explanation.*

a. Mixed and broken stratification, roots, soil, etc., 2-4 feet.
b. Loam and sandy loam, 3-6 feet.
c. Oblique strata of light sand.
d. Loam and light sand.
e. One layer of sand—blown out, 8 inches.
f. Oblique layers of sand.
g. Horizontal strata of fine sand.
h. Strata of fine sand, or clay.
i. Sloping clay layers, damp, rusty.
j. Dry, blowing sand.
k. Wet clay with rusty lumps.
l. Contorted, curling, or massive strata.
x. Hid from view by debris.

The full hight of the bank is about 20 feet where the section is taken. At a point further to the right than is shown in the sketch a couple of bones were found, but in the confused and broken uppermost layer. They were where that layer comes down to the river, and about 3 feet below the surface, or 5 feet above the water of the dam, the surface of the bank sloping about 45 degrees.

At Hokah the village is on a terrace 65 feet above the flood-plain of Root river, and there is a distribution of loam about the bluffs at a higher level, (as well as at many other points along Root river valley) reaching to a hundred feet, or a little more, above the flood-plain. This loam appears in indistinct benches or terrace-levels, or patches of terrace, rising often with a slope, far up the rock-bluffs. It very rarely appears level, as a well-marked terrace. It

suggests rather a worn-out old terrace-level, the upper surface of which has suffered erosion by being gullied out and smoothed off toward the river. It is generally cultivated for farms, and has good wheat-fields, consisting of the same materials as the lower terrace. Its actual hight is difficult to ascertain.

SW. ¼ Sec. 22, La Crescent. By the roadside appears a terrace rising about 50 feet, which at the top consists of the fine loam of which the foregoing terrace is composed, showing at least eight feet of such material, while its lower 20 feet are of drift-gravel, which is coarse and obliquely stratified, the coarsest pebbles being one or two inches in diameter. This occurs on the rounded point of the rock-bluff which faces both valleys.

The village of La Crescent stands on a beautiful terrace of drift-gravel, generously laid out, with wide streets and alleys, 50 feet above the flood-plain of the Mississippi. This terrace slopes gradually toward the high rock-bluffs. It is surmounted, along the bluffs, by another terrace, rising 40 feet higher, which consists of loam.

This drift-gravel must be attributed to the agency of the river. It has every feature of a water-worn alluvial deposit. It is not found in Houston county in any of the valleys of other streams, back from the Mississippi. It ante-dates the loess loam, as that is terraced above it, and probably bears the same relation to an earlier glacial epoch as the terraced loam does to the last.

At Brownsville the loam-terrace is 80 feet above the flood-plain of the Mississippi.

At Yucatan the terrace flat is 40 feet above the present flood-plain of the South Fork of Root river. The flood-plain is 6 feet above low water.

At Freeburg the terrace is 20 feet the flood-plain of Crooked creek, which is 5 feet above the water of the creek.

### *Wells in Houston County.*

A few wells situated in the valley of Root river have disclosed vegetable remains at about the level of the flood-plain, and probably the terraces generally cover a layer of vegetable remains that was caused by the decay and burial of pre-glacial plants. This has only been detected, so far as known, at Hokah, and at La Crescent. At the former place the well of Isaac West was filled again because the "muck-bed" rendered the water unfit for use. The same is true of William Wykoff's and W. F. Weber's, and a number of

others. Probably the characters of Mr. Pidge's, as given below, are those common to most of them.

*B. F. Pidge's Well at Hokah.*

It is situated on the lower terrace.

| | Feet. |
|---|---|
| Loam and sand.................... ........................... | 50 or 55 |
| Vegetation, leaves, stick, muck, &c,............................ | 4 |
| Sand, with some course pubbles, "literally filled with snail shells" | 4 |
| White sand, yielding water...................................... | 5 |

The water of this well tastes rather peculiar, and at first it was not fit for use. Sometimes still it comes up black, like dye, but by use it becomes clearer, and is used for all domestic purposes, without injurious effects. Sugar of lead causes it to become milky white. Acetate of potassa produces no change; sulphate of zinc no change. When it rises in the bucket it is not clear, but somewhat cloudy, as if with clay.

The well of Mr. Thos. Fairbanks, at Mound Prairie, disclosed a bone, now said to be in the possession of Dr. Armstrong, at Hokah. Efforts that have been made to secure facts in referrence to this discovery, and further account of the bone, have been unsuccessful.

## Wells in Houston County.

| Owner's Name and Location | Loam, Feet. | In the Rock, Ft. | Total Feet. | Kind of Water. | Remarks. |
|---|---|---|---|---|---|
| Timon Gilbertson, Spring Grove | 7 | 40 | 47 | Good. | |
| Mons Fladager, Spring Grove | 8 | 122 | 130 | Good. | Drilled. |
| Ingval Miller, Spring Grove | 10 | 30 | 40 | Good. | On lower ground. |
| Nels Hendrickson, Spring Grove | 8 | 77 | 85 | Good. | |
| Ole Thompson, section 7, Willmington. | 8 | 65 | 73 | Good. | |
| J. Dailey, N. E. ¼, section 34, Caledonia | 28 | 72 | 100 | ........ | No water. |
| Public Well, Caledonia | 25 | 245 | 270 | Good. | |
| W. N. West, Caladonia | 20 | 50 | 70 | Good. | |
| A. Calmus, Caledonia | 20 | 23 | 43 | Good. | |
| M. Creagan, Caledonia | 20 | 23 | 43 | Good. | |
| O. A. Bye, S. W. ¼, section 17, Willmington | 18 | 77 | 95 | Good. | Two feet sandrock ; 64 feet limerock ; 11 feet sandrock. |
| W. H. Harris, Caledonia. | 18 | 33 | 51 | Good. | |
| M. Newberry, Sheldon | 86 | .......... | 36 | Good. | The rock has never been struck at Sheldon. |
| J. B. Williams, Sheldon | 36 | .......... | 36 | Good. | |
| Cottrell Hotel, Houston | 16 | .......... | 16 | Good. | Eight feet to water. All alluvium. |
| W. R. Anderson, La Crescent | 57 | .......... | 57 | Good. | At 54 feet struck leaves, &c. |
| D. Gurley, La Crescent | 49 | .......... | 49 | Good. | Gravel and sand. |
| Sawyer House, La Crescent | 45 | .......... | 45 | Goed. | Gravel and sand. |
| James Day, La Crescent | 50 | .......... | 50 | Good. | Gravel and sand. |
| James Brown, La Crescent | 45 | .......... | 45 | Bad. | Sticks and leaves ; refilled. |
| J. Knapp, La Crescent | 63 | .......... | 63 | Good. | Gravel and sand. |
| Wm Miller, La Crescent | 30 | .......... | 30 | Good. | On lower ground. |
| Chas. Oldenbaugh, La Crescent | 20 | .......... | 20 | Good. | On low ground, near the rock bluff. |
| Thomas Minshall, La Crescent | 37 | 11 | 48 | Good. | On low bench. |
| Jos. Garner, La Crescent | 30 | .......... | 30 | Good. | On low bench. |
| Nicholas Prive, section 31, Caledonia | 12 | 2 | 14 | Good. | Four feet of water. |
| B. Smitz, section 32, Caledonia | 12 | 10 | 22 | Good. | Ten feet in sandrock. |
| N. Charles, section 32, Caledonia | 12 | .......... | 12 | Good. | |
| G. Anderson, section 4, Willmington | ....... | .......... | 40 | Good. | Drilled. |
| John Prive, section 33, Caledonia | 12 | 90 | 102 | Good. | |
| M. Blasen, section 33, Caledonia | 12 | 36 | 48 | Good. | |
| Ole Hanson, section 4, Willmington | 15 | 55 | 70 | Goed. | Drilled. |
| Peter Carrier, section 32, Yucatan | 55 | .......... | 55 | Goed. | In the valley : no rock struck. |

Throughout the county are numerous springs, some of which are very large, and gush out along the valleys. They seem to be the outlets of subterranean streams. Those above Riceford furnish the water for the flouring mills at that place. There is also a large one on Sec. 17, Caledonia, three miles south of Sheldon. They seem to frequent the horizon of about 80 feet below the top of the St. Lawrence limestone, and indicate a shaly, or otherwise impervious, layer there in that formation.

### *Material Resources.*

The rocks of the county do not contain any valuable minerals. They are everywhere abundantly exposed, and are quarried at many places for ordinary building-stone and for quicklime.

### *Building Stone.*

At Spring Grove the Lutheran society is building a large church, of brick, the basement being from the Lower Trenton, in layers of four to six inches, taken from quarries near the village. The heavy trimmings are from the St. Lawrence limestone. The quarries are owned by George Timansen and Ole Tostenson.

The Toledo Woolen Mill, of Fletcher & Williams, Sec. 5, La Crescent, is built of the St. Lawrence, quarried near.

At Caledonia the St. Lawrence is extensively used for building, quarried about a mile east of the village. The German Catholic church is the principal building made of it, being also the largest building in the place. The county jail is a fine building of the same, the courses being about ten inches thick, rubble dressed, with trimmings of the same. The business blocks of Nicholas Koob, J. J. Belden, John Krantz, Joseph Vossen, Jacob Bouquet and Nix Erstine are also constructed of the same stone. The quarries are owned by John Molitor, John Dorsh, Anton Molitor, Widow Cunningham and John Aiken.

On Sec. 24, Spring Grove, Mr. K. Gilbertson has a two-story stone residence on his farm, quarried from the Trenton.

At Money Creek, Harvey Chapel has a quarry that furnishes good stone for building, though much of that which is used is taken from the surface near the tops of the bluffs, having been loosened and broken up by the weather.

On the NE. ¼ Sec. 11, Caledonia, is Mrs. M. Brown's stone house, built of the Lower Magnesian.

Mr. J. Kline has a fine farm-house of stone taken from the St.

Lawrence, on Sec. 19, Union. Near Mr. Kline's quarry is an other owned by Henry Snure. There is another on Sec. 29, Union, owned by Michael Wilhelm. L. Svenson's is on Sec. 2, (S. E.) Houston.

The principal quarries at Hokah, now worked, are those of Nath. Whiteman, in the St. Croix sandstone, and Widow Prindle. The stone of Mr. Whiteman's quarry is a harsh, argillaceous sand-rock, in layers a few inches thick, which becomes firmer on exposure. The best building stone lies higher up in the bluffs, and was opened in Mt. Tom by the S. M. R. R. for the construction of their shops. It is from the St. Lawrence.

At La Crescent the public school-house was built of stone from Potter & Taylor's quarry, likewise in the St. Lawrence, north of La Crescent, in the edge of Winona county.

Lang's brewery, Sec. 28, Hokah, is a large stone building near the river, built of limestone from near the top of the bluff.

There is also a fine stone farm-house owned by Wm. Splitter, on Sec. 21, La Crescent, in Root river valley. The Nunnery, Sec. 28, La Crescent, was constructed of stone got from the bluffs near, including also that used for quicklime. These are all from the St. Lawrence.

On Winnebago creek (Sec. 22, Winnebago,) Mr. B. T. Barbour has a stone flouring mill.

O. T. West has a limestone quarry at Brownsville, which supplied heavy stone for the railroad and for other uses. Mr. Job Brown's, at the same place, furnished the limestone foundation for the public school-house.

The foregoing are a few of the stone buildings in the county, but there are several others which, though noticed in the progress of the survey, were not carefully located, and cannot be referred to. The St. Lawrence supplies by far the greater portion of the building-stone used in the county. There is not a single known workable quarry in the Shakopee, though exposed as favorably as the St. Lawrence. It is uniformly ignored. It is harder to work, has cherty lumps and siliceous concretions which not only disturb the bedding but render it difficult to cut into desired shapes, and is generally in thinner layers. The color is much the same as that of the St. Lawrence, being buff, or slightly salmon-colored, but the St. Lawrence is, where most used for building, also somewhat open or vesicular in texture. Thus mortar sets firmly upon it, and forms a sutured attachment. When the St. Lawrence stone is first taken out it cuts more easily than after exposure for a few

weeks, a fact which seems to be true of nearly all good building stone.

*Strength of Minnesota Building-stones.*

A series of experiments has been carried on by Gen. Q. A. Gilmore, under the direction of Gen. A. A. Humphreys, Chief of Engineers, U. S. A., during several years, on the strength of varirious building-stones in the United States. The tests that have been made are conducted with great care and precision, and demonstrate the compressive strength, specific gravity and ratio of absorption, of the stones tested. In the report of the Chief of Engineers for 1875 is a general table giving results, and in that table are named the following building stones from Minnesota. Two-inch cubes were crushed under a powerful press.

| Kind and Location. | Position in trial. | Strength of Specimen | Strength per Sq. Inch. | Specific Gravity. | Weight of Cubic Feet. | Ratio of Absorption. | Remarks. |
|---|---|---|---|---|---|---|---|
| | | Pounds. | Pounds. | | Pounds. | | |
| *Granytes.* | | | | | | | |
| Dark Syenytic granyte, Duluth | On bed. | 70,200 | 16,950 | 2.780 | 173.7 | 1-711 | |
| Dark Syenytic granyte, Duluth | On bed. | 75,200 | 18,200 | 2.800 | 175. | 0 | |
| Dark Syenytic granyte, Duluth | On bed. | 66,500 | 16,025 | 2.800 | 175. | 0 | |
| Dark Syenytic granyte, Duluth | On bed. | 67,200 | 16,200 | ... | ... | Slight. | Specific gravity not reported. |
| Dark Syenytic granyte, Duluth | On edge. | 67,950 | 16,387 | ... | ... | Slight. | Specific gravity not reported. |
| Light colored, St. Cloud | On bed. | 63,900 | 15,900 | 2.69 | 168.2 | 1-239 | |
| Light colored, St. Cloud | On edge. | 73,200 | 17,700 | 2.69 | 168.2 | 1-239 | |
| *Other Granytes.* | | | | | | | |
| Dark granyte, Quincy, Mass | ... | 70,200 | 16,950 | 2.660 | 166.2 | Very slow. | Cracked at 18,700 pounds. |
| Light granyte, Quincy, Mass | ... | 58,200 | 13,950 | 2.695 | 168.7 | Very slow. | Cracked at 17,200 pounds. |
| Bluish-gray, Keene, N. H. | On bed. | 40,200 | 9,575 | 2.656 | 166.0 | 1-800 | Used in inside of New Capitol, Albany, N. Y. |
| *Limestones.* | | | | | | | |
| Pink limestone, Kasota, Minn | On bed. | 42,000 | 9,900 | 2.630 | 164.4 | 1-56 | The "Shakopee" limestone. Specimen cracked at 26,200 pounds |
| Pink limestone, Kasota, Minn | On edge. | 45,900 | 10,875 | 2.630 | 164.4 | 1-56 | Did not crack before crushing. |
| Light-buff, Frontenac, Minn | On bed. | 24,200 | 5,450 | 2.325 | 145.3 | 1-28 | The "St. Lawrence Limestone." |
| Light-buff, Frontenac, Minn | On edge. | 30,200 | 6,975 | 2,325 | 145.3 | 1-28 | The "St. Lawrence Limestone." |
| *Other Limestones.* | | | | | | | |
| White, Marblehead, Ohio | On bed. | 44,200 | 10,450 | 2.4 | 150. | 1-30 | The "Corniferous." |
| White, Joliet, Ill | On bed. | 57,800 | 13,850 | 2.54 | 158.8 | 1-91 | The "Niagara" |
| Bluish-drab, Lemont Quarry, Cook Co., Ill | On bed. | 47,200 | 11,200 | 2.645 | 165.3 | 1-89 | |
| *Sandstones.* | | | | | | | |
| Purple sandstone, Fond du Lac, Wis* | On bed. | 24,200 | 5,450 | 2.220 | 138.8 | 1-22 | "Potsdam andstone." |
| Purple sandstone, Fond du Lac, Wis | On bed. | 24,100 | 5,425 | 2.220 | 138.8 | 1-22 | "Potsdam Sandstone" |
| Purple sandstone, Fond du Lac, Wis | On edge. | 19,640 | 4,310 | 2.220 | 138.8 | 1-22 | "Potsdam Sandstone." |
| Purple sandstone, Bass I., Wis | On bed. | 21,000 | 4,650 | 2.040 | 127.5 | 1-15 | "Potsdam Sandstone." |
| Purple sandstone, Bass I., Wis | On bed. | 16,200 | 3,450 | 2.040 | 127.5 | 1-15 | "Potsdam Sandstone." |
| Purple sandstone, Bass I., Wis | On edge. | 16,350 | 3,487 | 2.040 | 127.5 | 1-15 | "Potsdam Sandstone." |

* These are probably from Fond du Lac, Minn.

### *Sand.*

The St. Peter formation is excavated for mortar-sand by Jesse Schofield, Sec. 14, Caledonia, and by John Burns on Sec. 26. This white sand is delivered at Caledonia village for $1.25 per load, or occasionally for $1.50.

The St. Croix furnishes a similar sand near Mr. Kline's, Sec. 16, Union. These formations will supply a similar sand in any part of the county where they are accessible, the layers in the St. Croix, however, are about 200 feet below the top of the formation.

At Mr. Schofield's sand quarry, about a mile west of Caledonia, is a large mass of "lamellar calcite," lying on the slope of the St. Peter, and nearly covered by the loam. In that respect it is like a similar mass seen near St. Charles, in Winona county, in 1872, and mentioned in the report for that year, but it seems more firm than that. This appears like a firm, very compact rock, consisting of almost pure carbonate of lime, but somewhat colored. It is mainly massive, and striated, or laminated, but shows some crystalline grains. It weathers into undulating or wavy, smooth surfaces. There is another much larger mass, weighing many tons on the land of Mr. Willard, a short distance west. These masses can be burnt into a purely white quicklime of great strength.

The age and origin of this calcite involves an interesting problem. When that piece was found in Winona county, in 1872, it was referred hypothetically to the Trenton Green Shales, or to the worn-out Cretaceous that may have covered that country, making it of rock origin, either Lower Silurian or Mesozoic, but there is much reason to believe these calcite masses are not referable to the rock *in situ*, but are of atmospheric origin, being, in short, the remains of immense travertine deposits from limy water running down the St. Peter slope from springs that once existed but are now dry. They lie on the slope of the outcropping edge of the St. Peter, just below the Green Shales which shed all the water that works downward through the Upper Trenton limestone ; but they are also, so far as discovered, in regions where the Upper Trenton does not now exist, the only remaining portion of the Trenton being that which lies below the Green Shales. This is strikingly the case near Caledonia, where the Trenton is reduced to mounds and tables, capping the St. Peter sandstone, very far isolated from the main area of the Trenton. To suppose this calcite is due to springs caused by the Green Shales, a common phenomenon now in Fillmore county, is to require the former existence of the Upper Trenton, with a considerable thickness of strata, over all the re-

gion of Caledonia, and extending far enough north and east to furnish drainage surface sufficient to maintain such springs. This is not inconsistent with the history of geological changes, nor with the lapse of time since the Trenton was elevated to the condition of dry land. The present existence of isolated patches of the Lower Trenton, both in Minnesota and Wisconsin, can only be explained on the theory that the whole formation was once more largely spread in horizontal strata over those states, than at present. Then an extension of the Lower Trenton so as to embrace in one sheet of layers these isolated patches, is no more than enough to bring also the Upper Trenton into the region of these calcite masses. The present outlines, shape and position of the areas of the Lower Trenton, demonstrate that they are only the relics of once greater areas which have been eroded and removed slowly, and left as they are because they have been better protected against destructive agents. While Root river has been excavating the gorge in which it runs, 500 feet deep and two miles wide, the Trenton limestone, which at first may have extended as far northeast as to Hokah, has been slowly receding under the operation of denudation and surface drainage. These calcite masses, then, are relics of pre-glacial time, and perhaps of early pre-glacial time, since the last glacial epoch did not operate in Houston county so as to disturb the older surface.*

### *Brick.*

The loam everywhere is suitable for making brick, which are uniformly red. The following establishments were seen :

Stephen Robinson, Money Creek ; two miles south of the village

Fischer & Keller, Caledonia ; began last year ; burnt three kilns, and sold at $8.00 per thousand.

Brick were formerly made at La Crescent.

The Lutheran Society, at Spring Grove, manufacture on the spot a fine red brick from the loam taken out for foundations and basement of their large new church edifice.

### *Lime.*

The Trenton and the St. Lawrence furnish all the quicklime made in Houston county. There are no extensive manufacturers,

* See the First Annual Report, p. 47.

but the common pot-kiln is found at a number of points, by which enough is made to satisfy the local demands.

| | |
|---|---|
| Ole Timro, sec. 24, Money Creek | St. Lawrence. |
| Gilbert Nelson, Spring Grove | Trenton. |
| Michael Blasen, 1½ mile west of Caledonia | Trenton. |
| Peter Kreer, ne. ¼ sec. 29, Mayville | St. Lawrence. |
| John Gross, 1 mile nw. from Brownsville | St. Lawrence. |
| John Molitor, 1 mile east of Caledonia | St. Lawrence. |
| George Timansen, Spring Grove | Trenton. |
| Ole Tostenson, Spring Grove | Trenton. |
| Wm. E. Potter, LaCrescent | St. Lawrence. |
| Samuel Pound, sec. 12, Hokah | St. Lawrence. |

### *Lead.*

It is a common belief at La Crescent, held by Mr. Knapp, Mr. Day and others, that the lead enterprise at Dresbach, mentioned by Dr. Owen in his final report on the geology of Wisconsin, Iowa and Minnesota, was a speculating job, got up for the purpose of creating an excitement and selling land. The reputed discoverers were men from Galena, Ill., and the lead found is believed to have been brought from that place. The excitement soon died out, and all operations ceased the same season they began, and have never been revived. Whether this be true or not the rock, though not the same as that at Galena, is about the same as that in which are the lead mines in Missouri.

### *Earthworks.*

At La Crescent are a great many so-called *Indian Mounds.* Many have been graded away, but a good many still exist. They are on the brow of the drift-terrace, or lower bench, and none are known on the upper, loam-terrace. They are, as usual, in rude rows, and about three feet high, some of them being four feet. When opened they have been found to contain human remains of men of large stature, and it is said that in grading for the railroad a copper skillet and other trinkets were found at the depth of 18 feet below the surface.

# III.

# PALÆONTOLOGY.

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*Notes on the fossils of the Trenton limestone in Minnesota.*

Since the examination by Prof. James Hall, of the fossils of the Trenton, Black river and Birdseye limestones of New York, and the publication in 1846 of his large *pioneer volume* on the palæontology of the rocks of the United States, which makes the 1st volume of the New York State Palæontology, nothing so thorough as his work has been undertaken on the fossil contents of that geological horizon.

In Dr. Owen's report on the geology of Wisconsin, Iowa and Minnesota, which followed Prof. Hall's first volume, in 1851, a few species occurring at the falls of St. Anthony, and on Turkey river in Iowa, are described, and others are mentioned as identified at various other points in the northwest. The names applied are generally those of Prof. James Hall, and the identifications are based on those of the Trenton group of New York State.

In Foster & Whitney's Report on the Lake Superior Land District (1851) a few more species are described and figured by Prof. Hall, derived from the Trenton limestone in Michigan and Wisconsin.

In the First Canadian Decade (1859) by J. W. Salter, other species are described, particularly gasteropods, and there is also a full account of *Receptaculites occidentalis*, a genus which Prof. Hall first announced from the Trenton but failed to fully elucidate, owing to not having favorable specimens.

In the Third Canadian Decade (1858) Mr. Billings has named and figured a number of cystids from the Trenton rocks of Canada.

In the Fourth Decade (1859) the same eminent palæontologist describes the crinoids of the Trenton as found in Canada.

In 1861 was published by the legislature of Wisconsin a small

volume containing descriptions of a number of new species of fossils from the Trenton of that state by Prof. Hall, who was then State Geologist of Wisconsin. This contribution to the palæontology of the Lower Silurian was printed only in the legislative documents, and is very rare.

The Reports of the New York State Cabinet, containing the papers of the Curator, Prof. Hall, are many of them given largely to palæontology, and a number of them pertain to the Trenton limestone. These reports are issued annually, and now number 27.

In the Annual Reports of Progress of the Geological Survey of Canada, Mr. Billings also continued to add to our knowledge of the palaeontology of the Trenton, such material as was gathered in Canada. The reports for 1854, 1857 and 1858 contain matter relating to the Trenton. Subsequently to that he published his descriptions of fossils separately, and in 1865 was issued a fine volume on the Palæozoic fossils of Canada which was entirely the work of Mr. Billings, and contains figures of a number of Trenton species.

In 1863 appeared *The Geology of Canada*, which, however, only gives figures and names of species already described.

In 1868 was published the third volume of the publications of the Geological Survey of Illinois, which contains some descriptions of fossils from the Trenton and Galena formations, by Messrs. Meek and Worthen.

Meantime, in Tennessee, Prof. J. M. Safford had closely examined the fauna of the Trenton and Nashville series in that state, and without describing many new species he has given in his volume on the geology of that state much accurate information concerning its palæontology, as correlated to the same horizon in New New York state. This was published in 1869.

In 1874 appeared the first part of Vol. 2 of Palæozoic Fossils of Canada, by Mr. Billings, but it is mainly taken up with the Quebec Group.

By the aid of the foregoing works some progress has been made in the examination of the Trenton fossils of Minnesota. The specimens thus far examined are a part of those gathered by the Geological Survey of the State. The examination is far from complete. Indeed it has but just begun. Those have been named which are identifiable readily, leaving doubtful specimens, as far as the investigation has gone, to some future time when more pains can be taken to make sections and minute examinations. Moreover, there is a good collection of Trenton fossils in the cases

of the Minnesota Academy, and another in the Academy at St. Paul, while one of the best collections of Galena fossils that have ever been made is in the possession of Mr. Frank Wilson, at Mantorville, who has kindly loaned them to the Survey.

It is hoped that with the aid of these collections, after a while, a complete account of the Trenton fauna may be made out for the Northwest, and that the study of this formation—so long neglected—may be made more easy and attractive.

The following species have been identified already. This list, though very incomplete, is here given that it may be seen how far the work has gone:

*Cephalopoda.*

**Endoceras angusticameratum. Hall.**
**Endoceras magniventrum. Hall.**
**Orthoceras multicameratum. Con.**
**Endoceras proteiforme. Hall.**
**Endoceras proteiforme. Hall. Var strangulatum. Hall.**
**Endoceras distans. Hall.**
**Lituites undatus. Con.**
**Ormoceras tenuifilum. Hall.**
**Conularia Trentonensis. Hall.**
**Orthoceras bilineatum. Hall.**
**Orthoceras junceum. Hall.**

**10 species.**

*Gasteropoda.*

**Maclurea magna. Hall.**
**Murchisonia bellicincta. Hall.**
**Murchisonia bicincta. Hall.**
**Murchisonia perangulata. Hall.**
**Murchisonia angustata. Hall.**
**Pleurotomaria umbilicata. Hall.**
**Pleurotomaria ambigua. Hall.**
**Pleurotomaria lenticularis. Con.**
**Murchisonia subfusiformis. Hall.**
**Maclurea Logani. Sal.**
**Rhaphistoma lapicida. Salter (?)**

**11 species.**

*Brachiopoda.*

**Strophomena alternata. Con.**
**Strophomena tenuistriata. Sow. (a variety.)**

Orthis testudinaria. Dal.
Strophomena fluctuosa. Bill.
Discina Pelopea. Bill.
Rhynchonella capax. Con. (increbescens of Hall.)
Orthis plicatella. H.
Orthis subquadrata. H.(?)
Strophomena nitens. Bill.(?)
Lingula quadrata. Eich.
Orthis occidentalis. H.

Also undetermined species of Orthis Leptaena, Strophomena Chonetes, Lingula, Rhynchonella, and of the *Acephal*, Ambonychia.

11 species.

*Polyp Radiates.*

Petraia corniculum. H.
Chaetetes Lycoperdon. H.
Chaetetes petropolitanus. Pander.

3 species.

*Crustacea.*

Illaenus latidorsata. Hall (?)
Isotelus (Asaphus) gigas. Hall.

2 species.

*Protozoa.*

Receptaculites occidentalis. Sal.
Receptaculites Oweni. Hall.

2 species.

In addition to these there is a number of species that have been examined that have proved to be unidentifiable by the use of references accessible, and some of them may prove to be new to science.

Of the foregoing species the following pertain to the Lower Trenton or to the Green Shales that separate the Lower Trenton from the Upper, and may probably be found in the neighborhood of Minneapolis, or along the bluffs of the river below the Falls of St. Anthony :

Endoceras angusticameratum. Hall.
Endoceras magniventrum. Hall.
Endoceras proteiforme. Hall.
Endoceras distans. Hall.

Chaetetes Lycoperdon. Hall.
Chaetetes petropolitanus. Pander.
Rhaphistoma lapicida. Salter (?)
Petraia corniculum. Hall.
Orthoceras junceum. Hall.
Orthoceras multicameratum. Con.
Orthoceras bilineatum. Hall. (Record doubtful.)
Isotelas gigas. Hall.
Orthis testudinaria. Dal.
Rhynchonella capax. Con.
Lingula quadrata. Eich.

The specimens from the locality of Minneapolis have not yet been subjected to careful examination. There are known to be other species of brachiopods, graptolites and fucoids, besides gasteropods and corals.

The following have been identified from the Upper Trenton, not including the Galena:

Orthoceras multicameratum. Con.
Lituites undatus. Con.
Endoceras distans. Hall.
Receptaculites occidentalis. Sal.
Endoceras proteiforme. Hall. Var strangulatum. Hall.
Ormoceras tenuifilum. Hall.
Maclurea magna. H.
Maclurea Logani. Salter.
Pleurotomaria Lenticularis. Con.
Chaetetes petropolitanus. Pander.
Murchisonia subfusiformis. H.
Murchisonia bellicincta. H.
Receptaculites Oweni. H.
Rhynchonella capax. Con.

The following are known from the Galena within the limits of this State:

Endoceras magniventrum. Hall.
Endoceras proteiforme. Hall.
Receptaculites Oweni. Hall.
Petraia corniculum. H.
Conularia Trentonensis.
Strophomena alternata. Con.
Murchisonia bicicnta. H.
Isotelus gigas. H.

Murchisonia perangulata. H.
Murchisonia angustata. H.
Murchisonia bellicincta. H.
Pleurotomaria umbilicata. H.
Pleurotomaria ambigua. H.
Strophomena tenuistriata. H. (variety.)
Orthis testudinaria. Dal.
Strophomena fluctuosa. Bill.
Discina Pelopea. Bill
Orthis plicatella. H.
Orthis subquadrata. H. (?)
Strophomena nitens. Bill. (?)
Orthis occidentalis. H.

# IV.

# CHEMISTRY.

REPORT OF PROF. S. F. PECKHAM.

*Prof. N. H. Winchell:*

My Dear Sir:—I have the pleasure of reporting the chemical work on the Geological Survey for the past year as consisting of a complete analysis of the so-called, Russell Mineral Spring, in Minneapolis; four specimens of coal and their ashes the serial numbers of which are 11, 12, 13 and 14; No. 15, a sort of clay, and a stone known as the St. Lawrence limestone, of which there were two specimens numbered 30 and 31. I also report the analyses made for Messrs. Kindred and Culver in the fall of 1875.

The process of analysis employed for the coals was the same as that used by myself for the analysis of some 25 specimens belonging to the Geological Survey of California. The specific gravity was first determined by sifting the dust from the finely granulated coal and weighing in a sp. gr. flask, after standing under water at least 12 hours. One gramme was then weighed in a platinum crucible and dried at a temperature of 215°–220° Fahr. until it ceased to lose weight. The loss is water.*

The residue was then heated over a Bunsen's burner for 3.5 minutes, and then over a blast lamp for the same length of time, and weighed. The loss was considered to be volatile combustible matter. The residue was burned to an ash and the ash weighed. The loss from combustion was considered to be non-volatile combustible material, or fixed carbon.

*The question has been raised whether or no this loss be water. Very carefully conducted experiments were made during my research upon the California coals, to ascertain if the coal was oxidized by prolonged heating at the temperature above mentioned. The amount of water escaping was absorbed by chloride of calcium and weighed. It exactly corresponded to the loss experienced when the experiment was conducted as described above, and no oxidation products could be detected.

In conformity with your wishes I also made a quantitative analysis of the ashes of each of these coals.

The coals are quite unlike. Nos. 11 and 12 are semi-cannel coals. No. 13 consists of a mass of clay containing carbonaceous matter. No. 14 consists of an earthy mass, chiefly silica containing fragments of mineral charcoal.

No. 11 is homogeneous and brittle, of a dull black color, and cracks in a dry atmosphere. When heated it is non-caking, the pieces retaining their form and size, and in this respect it resembles some of the cretaceous coals of the Pacific coast. The results of analysis are as follows:

| | | |
|---|---|---|
| Specific gravity | 1.441 | |
| Water | 13.53 | per cent. |
| Volatile combustible matter | 54.11 | " |
| Fixed carbon | 29.49 | " |
| Ash | 2.87 | " |
| | 100.00 | " |

The ash contained—

| | | |
|---|---|---|
| Insoluble silicic acid, etc | 3.698 | per cent. |
| Soluble silicic acid | 14.159 | " |
| Sulphuric acid | 23.363 | " |
| Ferric oxide and alumina | 23.419 | " |
| Lime | 7.592 | " |
| Magnesia | 16.055 | " |
| Carbonic acid, chlorine, alkalies, etc | 11.714 | " |
| | 100.000 | " |

The total amount of combustible matter in this coal is 83.60 per cent.

No. 12 in some respects resembled No. 11. It is a semi-cannel in appearance, very friable in dry air, and non-caking. The results of analysis are as follows:

| | | |
|---|---|---|
| Specific gravity | 1.425 | |
| Water | 12.70 | per cent. |
| Volatile combustible matter | 38.32 | " |
| Fixed carbon | 45.61 | " |
| Ash | 3.37 | " |
| | 100.00 | " |

The ash contained—

| | |
|---|---|
| Insoluble silicic acid, etc | 8 338 per cent. |
| Soluble silicic acid | 22.963 " |
| Sulphuric acid | 19.674 " |
| Ferric oxide and alumina | 20.006 " |
| Lime | 16.353 " |
| Magnesia | 3.946 " |
| Carbonic acid, chlorine, alkalies, etc | 8.720 " |
| | 100.000 " |

The total amount of combustible matter in this coal is 83.93 per cent.

No 13 is a specimen of dark colored clay containing an unusual amount of organic combustible matter, not enough, however, to give it any value as fuel. It burns to a very light-colored ash consisting largely of alumina, and would therefore in all probabilty make very good brick if sufficient sand were mixed with it. The results of analysis were as follows :

| | |
|---|---|
| Specific gravity | 1.968 |
| Water; Volatile combustible matter; Fixed carbon | 29.55 per cent. |
| Ash, consisting of clay | 70.45 " |
| | 100.00 " |

The ash contained—

| | |
|---|---|
| Insoluble portion, consisting of insoluble alumina and silicic acid | 92.751 per cent. |
| Soluble silicic acid | .490 " |
| Sulphuric acid | .282 " |
| Ferric oxide and alumina | 2.894 " |
| Lime | 1.076 " |
| Magnesia | .348 " |
| Undetermined matters | 1.159 " |
| | 100.000 |

No. 14 consisted of a soft, siliceous rock, containing small fragments, grains and specks of mineral charcoal. The results of analysis are as follows :

| | | |
|---|---|---|
| Specific gravity | 2.141 | |
| Water and combustible matter | 26.54 | per cent. |
| Ash | 73.46 | " |
| | 100.00 | " |

The ash contained—

| | | |
|---|---|---|
| Insoluble matter, chiefly silicic acid | 96.549 | per cent. |
| Soluble silicic acid | 0.836 | " |
| Sulphuric acid | 0.178 | " |
| Ferric oxide and alumina | 0.257 | " |
| Lime | 1.023 | " |
| Magnesia | 0.462 | " |
| Undetermined matters | 0.695 | " |
| | 100.000 | |

No. 15 is a dull-green, amorphous mineral, unctuous and soapy to the touch. Fracture uneven, coarsely granular. Hardness 1.5. Easily cut with a knife, giving a smooth surface. Specific gravity 2.562. Lustre dull, waxy, with very minute pearly scales. Color mottled, dull-green to grayish-green, opaque, scales translucent. When wetted it absorbs water and softens, but does not become plastic.

In closed tube it gives water. B.B. infusible. Gives blue color with cobalt, which is indistinct from excess of iron. Is decomposed by hydrochloric acid, leaving a white insoluble residue containing only a trace of iron. The oxidation of the iron varies according to the extent of the exposure. The following are the mean results of three closely concordant analyses:

| | | |
|---|---|---|
| $Si\,O_2$ | 37.88 | per cent. |
| $Fe_2\,O_3$ | 15.78 | " |
| $Al_2\,O_3$ | 26.96 | " |
| $Mg\,O$ | 1.74 | " |
| $K_2\,O$ } $Na_2\,O$ } | 0.95 | " |
| $H_2\,O$ | 15.88 | " |
| | 99.16 | " |

A trace of lime was not determined.

These results show the mineral to be allied to Fahlunite, var. Huronite of T. S. Hunt. See Dana's Mineralogy, Ed. 1870, p. 485.

It is doubtless one of the numerous decomposition products of a ferruginous Feldspar.

Nos. 30 and 31 are pieces of the St. Lawrence limestone. This stone consists of a hard, siliceous, magnesian limestone containing sufficient iron to give it an ocherous shade of color with yellowish streaks. It also contains angular grains of quartz and small grains of a green mineral quite uniformly distributed through the rock. These grains are of all sizes from that of a large pin's head to those of scarcely preceptible dimensions. They are irregularly spherical in form, sometimes slightly flattened, or elongated. Cold commercial hydrochloric acid dissolves all of the constituents of the rock except the grains of quartz and the green grains. By sifting and careful sorting, the largest of the green grains may be obtained quite pure. The specific gravity of these grains is 3.634—Hardness about 2.0. B. B. infusible becoming brown from oxidation of iron. In the closed tube gives water becoming more or less oxidized. The following are the mean results of three analyses :

| | | |
|---|---|---|
| $Si O_2$ | 48.20 | per cent. |
| $Fe O$ | 27.09 | " |
| $Al_2 O_3$ | 6.94 | " |
| $K_2 O$ | 7.54 | " |
| $Na_2 O$ | 1.02 | " |
| $H_2 O$ | 8.72 | " |

These characteristics and results give a variety of Glauconite not decomposed by hydrochloric acid. See Dana's Mineralogy, Ed. 1870, p. 462.

Russell Mineral Spring Water. This water flows from a spring in the cellar of the house at present occupied by Perkins Russell, Esq., on the corner of Fifth street and Fifteenth avenue S. E., in this city. The flow of the spring is very uniform throughout the year and the volume is copious, bubbling up in the center of a curbed area about four feet in diameter. On exposure to the atmosphere the water deposits sesqui-oxide of iron. No gas escapes from super-saturation. The water is very clear and sparkling, with a slight green color and the taste of a dilute solution of hydrosulphuric acid gas.

Analysis showed that one U. S. wine gallon of 231 cubic inches contains of,

| | | Grains. |
|---|---|---|
| Potasium chloride, | $K\,Cl$ | 0.170161 |
| Sodium chloride, | $Na\,Cl$ | 1.226701 |
| Calcium chloride, | $Ca\,Cl_2$ | 0.393765 |
| Calcium carbonate | $Ca\,CO_3$ | 10.060996 |
| Calcium sulphate, | $Ca\,SO_4$ | 0.867690 |
| Calcium Phosphate, | $Ca_3\,(PO_4)_2$ | 0.171380 |
| Magnesium carbonate, | $Mg\,CO_3$ | 4.371058 |
| Iron proto-carbonate, | $Fe\,CO_3$ | 0.169227 |
| Manganese proto-carbonate, | $Mn\,CO_3$ | 0.032561 |
| Silicic oxide, | $Si\,O_2$ | 1.393182 |
| Organic matter, | | 0.208340 |
| Sodium biborate, | | A trace. |
| Potassium nitrate, | | A trace. |
| Ammonium chloride, | | A trace. |
| Calcium fluoride, | | A trace. |
| Barium carbonate, | | A trace. |
| Barium sulphate, | | A trace. |
| Total solid matter, | | 19.065061 |
| Specific gravity at 60° Fahr. | | 1.000638 |
| Temperature, | | 45.5° Fahr. |

At that temperature one gallon contains of

| | | |
|---|---|---|
| Carbonic acid gas, | $CO_2$ | 41.037432 C. inches. |
| Of which is combined to form bicarbonates, | | 25.651171 C. inches. |
| Leaving in solution, | | 15.386261 C. inches. |

The water also contains an amount of hydrogen sulphide ($H_2\,S$), varying in amount at different times from a trace to a few cubic inches per gallon.

These results give a water of somewhat peculiar character, yet not sufficiently remarkable in any respect to lead one to expect unusual results to follow its use. The amount of solid matter is small and consequently all of the ingredients present are found in small proportion; yet we find, on comparing these results with the analysis of other waters, that the amount of calcium phosphate present is relatively large. The reputation which the water has attained as a remedial agent, may be, in part, due to the presence of this salt, or it may be due to the peculiar combination presented by the simultaneous presence of phosphate of lime, proto-carbonate of iron and sulphide of hydrogen.

It may be said, however, that the causes producing certain physio-

logical effects are very obscure, and when these effects are observed to follow the use of complex mixtures dissolved in large quantities of water, but little satisfaction can be gained from theoretical speculations that attribute them to the presence of one or the other ingredient of the mixture. But little more can be said than that the water contains small quantities of substances that give, when found in large proportions, the specific characters to seltzer, chalybeate, and white-sulphur springs, and that its use in many instances has been attended with beneficial results.

In accordance with your request, that I should furnish you the results of the analyses that were made in the fall of 1875 for Messrs. Kindred and Culver, I submit the following:

I. Three specimens supposed to contain silver were sent to Dr. P. B. Rose to be assayed. The first two were from J. B. Culver, Esq., of Duluth, and were reported as not containing silver. The third specimen was from C. F. Kindred, Esq., of Brainerd. It was reported as containing "52.32 oz. of silver to the ton of ore, which at $1.30 per oz. = $68.01 per ton."

II. A sample of iron ore, supposed to contain tin, from the neighborhood of Duluth, was sent to Prof. E. W. Morley, of Hudson, Ohio, a gentleman of large experience on iron assays. He reported two assays as yielding iron, 16.19 per cent. and 16.17 per cent. "Tin not present in any appreciable quantity. The ore appeared to contain quite a notable quantity of Titanium. Titanium is now supposed to be injurious. * * The amount of iron in the ore is so small that iron produced from it could hardly compete with richer ores, even if flux and coal were both near at hand. One would not like to say the ore is valueless without knowing the relative amount of silica and calcium in the ore; but the probability that they are in such proportions as to render the addition of a flux needless, is very slight."

Another sample of iron ore from near Duluth, was sent Prof. Morley with instructions to determine the quantity of any thing he might find in it of commercial value. After giving the details of the process of analysis, he says: "You will see that everything of any commercial value is pretty thoroughly excluded. It is an iron—magnesium—sodium silicate; with not enough iron to make it of value as an iron ore."

The first mentioned iron ore resembles an iron ore found in the northern part of Rhode Island, where it occurs in a protruded mass, in some respects resembling porphyry.

Respectfully submitted,

S. F. PECKHAM,
State Chemist.

MINNEAPOLIS, Jan. 9, 1877.

# V.

# BOTANY.

The survey has received a hearty response to the following circular, which was issued in conformity with the instructions of the Regents, in the spring of 1876:

## THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

(BOTANY.)

*To the Botanists of the State:*

At the annual meeting of the Board of Regents, held in St. Paul in December, 1875, action was taken ordering the commencement of a thorough and systematic examination of the flora of the state. This was done in conformity to the law ordering a geological and natural history survey of the state, and placing it in charge of the Regents of the University. One clause of that law reads as follows:

"SEC 3. The natural history survey shall include, first, an examination of the vegetable productions of the state, embracing all trees, shrubs, herbs and grasses native or naturalized in the state; second, a complete and scientific account of the animal kingdom as properly represented in the state, including all mammalia, fishes, reptiles, birds and insects."

In the prosecution of this examination it is expected that the Regents will have the assistance of the botanists of the state, and it is for their information that the following suggestions are made concerning the collection and preservation of information, and especially of botanical specimens.

1st. Make as full notes as possible on the flora of your own locality, not only naming species, but mentioning peculiarities and variations of structure, habitat, color, and relative abundance. Recollect that there is no published text book that professes to give an account of the flora of the country west of the Mississippi in this latitude, and that you are very largely

an independent observer. Therefore repeated verifications of an observed variation or peculiarity, or of a species not named in the familiar text-books, should be made *before reporting such observation as a fact.*

2d. Collect and preserve as many specimens as possible. They will exemplify the local flora of your region, and will serve as duplicates for exchange with other portions of the state and with foreign botanists. The most valuable portion of your contribution to the survey will be, after all, the collections which you may make and forward for careful identification.

3d. It is the design of the Regents to collect together at the University, a complete representation of the plants of the state as ordered by the law, and to have them so arranged and exhibited that they can be seen for comparison by any of the botanists of the state that may wish to examine them.

4th. For aid in the study of the flora of the state, the following works will be useful:

Gray's *Manual of Botany.*

Torrey & Gray's *Flora of North America*, 2 vols., to *Lobeliaceæ.*

De Candolle's *Prodromus*, 18 vols., down to *Endogenae.*

U. S. Geological Exploration of the Fortieth parallel. Vol. V, Botany. (Watson.)

Pacific R. R. Reports.

Transactions of the St. Louis Academy.

Proceedings of the American Academy, Philadelphia.

*Catalogue of the Plants of Minnesota*, by I. A. Lapham, published in the Annual Report of the State Horticultural Society for 1875. Furnished by the Secretary of the Society.

Hayden's *Nebraska Plants.*

Hooker's Fl. Bot. Am., 2 vols.

Flora of Colorado, I vol., Porter & Coulter.

Nuttall's Genera, 2 vols.

Bentham's Genera, 4 parts.

5th. It is evident that there is no botanist, nor even any public library in the state that possesses the books necessary for the thorough study and satisfactory determination of the species of our flora. Within certain limits our flora can be studied, but the burden of our first efforts must be the collection of specimens. Their exhaustive study can only be done by experts, with the fullest facilities for comparison.

6th. The present design of the survey is to act as a means of communication between botanists of the state, to enable them to compare specimens, and as a depository for duplicates. To this end exchanges will be made with such as desire to compare species, and any aid or information will be rendered that it is possible to give. Lists of the local flora in different parts of the state should be made out as thoroughly as possible, to judge of the distribution of species. The areas that are covered with timber in the various counties, or townships, and the kinds of trees, should be stated. It is highly desirable that a local botanist be assigned to the working up of each county. For this purpose, the survey should be furnished with the

names of such botanists as are known to be interested in our state flora. Annual reports made by such local botanists would indicate the progress of the work.

N. H. WINCHELL.

THE UNIVERSITY OF MINNESOTA,
May 1st, 1876

The survey has received several hundred specimens representing the flora of the state, and others have been gathered by Mr. Leonard and Mr. Herrick, assistants on the survey. Nothing systematic has been attempted in the way of identifications, but through the kindness of others, chiefly Mr. O. E. Garrison, of St. Cloud, and Dr. A. E. Johnson, of Minneapolis, valuable assistance has been rendered in determining our local flora.

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## FUNGI.

BY DR. A. E. JOHNSON.

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*Prof. N. H. Winchell*:—I believe no attempt prior to this has been made to collect and list the Mycologic Flora of Minnesota. As a small contribution to the Natural History of Minnesota, I present the following list of plants, in the Mycologic Flora of our state, for such use as you may be pleased to make of it.

The list has been collected mainly from Hennepin county; some from Anoka, Ramsey and Wright counties.

I have placed the Gen. or Sub-Gen. before each species; as for example, Sub-Gen. 1. *Amanita*. Hence, in reading *Agaricus vaginatus*, the word *Amanita* should be supplied thus: *Agaricus* (Amanita) vaginatus. *Bull*. And so with all the species under each Gen. or Sub-Gen. Following the specific name of the species are initials or letters used by botanists to designate the name of the author of the species, and immediately following is the common name of the plant if it has received one; then follow such words as, wood, woods, ground, sticks, stumps, epiphytal, terrestrial, etc., indicating the habitat, and lastly the month or months in which the plant is found in our climate. If there is but one month named, the plant has only been observed in that month, but if two months are named, as June, Nov. the plant has been observed in both months and most always during the intervening months:

DIVISION 1. Sporifera.

FAMILY 1. Hymenomycetes.

ORDER 1. Agaricini.

SERIES 1. Leucospori. Spores white.

SUB-GEN. Amanita *Pers.*

GEN. Agaricus. *L.*

1. Agaricus vaginatus. *Bull.* Slick Amanita. Woods. August.
2. A. Ceciliae. *B. & Br.* Grey, ringless Amanita. Woods. Aug., Sept.
3. A. adnatus. *Smith.* Adnate-gilled Amanita. Woody places. Aug.
4. A. vernus. *Bull.* Spring Amanita. Woods, open places. June to Aug
5. A. phalloides. *Fr.* Stinking Amanita. Woods. August, Nov.
6. A. mappa. *Batsch.* Delicate Amanita. Under trees. Poisonous.
7. A. muscarius. *L.* Fly Amanita. Thin woods. Aug. & Sept. Poisonous.
8. A. excelsus. *Fr.* Tall Amanita. Woods. Aug. and Sept.
9. A. pantherinus. *D. C.* Spotted Amanita. Woods and open ground.
10. A. asper. *Fr.* Rough Amanita. Woods. June to Sept.

SUB-GEN. Lepiota. *Fr.*

11. A. procerus. *Scop.* Parasol mushroom. Woods. Aug. to Sept.
12. A. excoriatus. *Schæff.* Flaky Lepiota. Woods. May to Sept.
13. A. gracilentus. *Krombh.* Slender Lep. Ground. Sept. Edible.
14. A. acutesquamosus. *Wm.* Squarrose Lepiota. Ground. July.
15. A. clypeolarius. *Bull.* Fragrant Lepiota. Woods. Ju.
16. A. Americanus. *Peck.* Prairies. Aug. to Sept.
17. A. cristatus. *Fr.* Stinking Lepiota. Woods, fields. Aug.
18. A. naucinus. *Fr.* Large spored Lepiota. Woods. Aug. to Sept.
19. A. granulosus. *Batsch.* Granular Lepiota. Forests. July.
20. A. polystictus. *Berk.* Little Brown Lepiota. Ground. July.

SUB-GEN. Armillaria. *Fr.*

21. A. melleus. *Vahl.* Honey-coloured Armillaria. W. Aug to Sept.

SUB-GEN. Tricholoma. *Fr.*

22. A. vaccinus. *Pers.* Scaly Tricholoma. Ground, in woods. Sept.
23. A. crassifolius. *Berk.* Thick-gilled Tricholoma. Larch swamps.
24. A. varigatus. *Scop.* Variegated Tricholoma. Ground. June, July.
25. A. sulfureus. *Bull.* Sulphury Tricholoma. Woods. July, Aug
26. A. gambosus. *Fr.* St. George's Mushroom. Grassy ground. June.
27. A. melaleucus. *P.* Changeable Tricholoma. Cleared ground. Sept.

SUB-GEN. Clitocybe. *Fr.*

28. A. nebularis. *Batsch.* Clouded Clitocybe. On ground in woods. Sept.
29. A. Adirondackensis. *Peck.* Smooth Clitocybe. Woods. Aug., Sept.
30. A. candicans. *Fr.* Whitish Clitocybe. Woods. Sept.
31. A. phyllophilus. *Fr.* Leaf-loving Clitocybe. Woods. Sept.
32. A. dealbatus. *P.* Ivory Clitocybe. Woods. July.
33. A. giganteus. *Fr.* Giant Clitocybe. Woods. Sept.
34. A. cyathiformis. *Fr.* Cup-shaped Clitocybe. Woods. Aug., Sept.
35. A. laccatus. *Scop.* Waxy Clitocybe. Woods. June-Oct.
36. A. cerussatus. *Fr.* White lead clitocybe. Larch. May.
37. A. radio-zonaria. *n. sp.* Radiated Clitocybe. Ground, wood. June.

A full description in Bulletin of the Minnesota Academy of Natural Sciences for 1876.

SUB-GEN. Pleurotus. *Fr.*

38. A. ostreatus. *Jacq.* Oyster Pleurotus. Trunks in woods. July.
39. A. seratinus. *Schrad.* Yellowish Pleurotus. Larch. May.
40. A. mastrucatus. *Fr.* Imbricated Pleurotus. On wood. June.
41. A. atrocœruleus. *Fr.* Blue-black Pleurotus. On wood. July.
42. A. sulfuroides. *Peck.* Pine logs, &c. Sept.
43. A. serotinoides. *Peck.* Trunks in woods. Nov.

SUB-GEN. Collybia. *Fr.*

44. A. radicatus. *Relh.* Rooting Collybia. Ground, stumps. July.
45. A. velutipes. *Curt.* Velvet-stemmed Collybia. Stumps. May.
46. A. confluens. *P.* Confluent Collybia. Woods. July.
47. A. cirrhatus. *Schum.* Cirrhate Collybia. June, September.
48. A. tuberosus. *Bull.* Tuberous Collybia. Ground, &c. Aug., Oct.
49. A. acervatus. *Fr.* Tufted Collybia. Woods. Aug., Oct.
50. A. xanthopus. *Fr.* Yellow-stemmed Collybia. Ground. July, Aug.
51. A. dryophilus. *Bull.* Wood Collybia. Epiphytal. June to Oct.
52. A. exsculptus. *Fr.* Sulphur-gill Collybia. Ground. Sept.
53. A. plexipes. *Fr.* Twisted Collybia. On trunks.
54. A. stipitarius. *Fr.* Fibrillose Collybia. Epiphytal. July to Aug.

SUB-GEN. Mycena. *Fr.*

55. A. praelongus. *Peck.* Epiphytal. Swamps. June to July.
56. A. paluster. *Peck.* Larch swamps. Sphagnum. June.
57. A. radius. *n. sp.* Pale-yellow Mycena. Ground. May.

See Bulletin of the Minn. Acad. of Natural Sciences. 1876.

58. A. strobilinus. *Pers.* Fir-cone. Mycena. Epiphytal.
59. A. purus. *P.* Amethyst Mycena. Larch swamps. June to July.

60. A. pauperculus. *Berk.* Little-stump Mycena. July.
61. A. sanguineolentus. *A. & S.* Stinking Mycena. June to Oct.
62. A. crocatus. *Schrad.* The Stainer. Woods. June to July.
63. A. epipterygius. *Scop.* Yellow-stem Mycena. July to Aug.
64. A. stylobates. *P.* Discoid Mycena. Epiphytal. Woods. Aug.
65. A. corticola. *Schum.* Bark Mycena. July, Aug.
66. A. capillaris. *Schum.* Capillary mycena. Leaves. Aug.

SUB-GEN. Omphalia. *Fr.*

67. A. pyxidatus. *Bull.* Variable Omphalia. Ground. July.
68. A. affricatus. *Fr.* Hairy Bog Omphalia. Ground. July.
69. A. muralis. *Sow.* Wall Omphalia. Ground. July.
70. A. umbilliferus. *L.* Common Omphalia. Ground. July. Sept.
71. A. rufulus. *B. & Br.* Reddish Ompahlia. Ground. July.
72. A. campanella. *Batsch.* Tawny Omphalia. Larch swamps.
73. A. chryseus. *Peck.* Logs in woods. August.
74. A. fibula. *Bull.* Button Omphalia. Ground. June, Oct.
75. A. gracillimus. *Weinm.* Delicate Omphalia. Epiphytal. Aug.
76. A. integrellus. *P.* Little-white Omphalia. Epi. Aug., Sept.

SERIES. 2. Hyporhodii. *Fr.*

SUB-GEN. Volvaria. *Fr.*

77. A. bombycinus. *Schæff* Silky Volvaria. Epiphytal. July, Aug.
78. A. volvaceus. *Bull.* Stove Volvaria. Ground. July, Aug.
79. A. Taylori. *Berk.* Taylor's Volvaria. Ground. Aug., Sept.
80. A. gloiocephalus. *Fr.* Umbonate Volvaria. Ground. June.

SUB-GEN. Chamæota. *Smith.*

81. A. cretaceus. *Fr.* Chalky Chamæota. Ground. Aug.

SUB-GEN. Pluteus. *Fr.*

82. A. cervinus. *Schæff.* Fawn Pluteus. Ground. May, Oct.
83. A. nanus. *P.* Mealy Pluteus. Logs in woods. Aug.
84. A. petasatus. *Fr.* Broad-capped Pluteus. Epiphytal. Aug.
85. A. leoninus. *Schæff.* Yellow Pluteus. On wood. Aug., Oct.
86. A. chrysophæus. *Schæff.* Dingy Pluteus. On wood. Aug.
87. A. phlebophorus. *Ditm.* Veined Pluteus. On wood. Aug.

SUB-GEN. Entoloma. *Fr.*

88. A. strictior. *Peck.* Ground. Sept., Oct.
89. A. sinuatus. *Fr.* Woods. Ground. Poisonous. July.
90. A. prunuloides. *Fr.* Plum-like Entoloma. Woods, ground. Sept.

91. A. helodes. *Fr.* Moor Entoloma. Ground, woods. Sept.
92. A. repandus. *Bull.* Repand Entoloma. Ground, woods. July.
93. A. ardociacus. *Bull.* Meadow Entoloma. Ground, woods. Sept.
94. A. sericellus. *Fr.* Silky Entoloma. Woods. Aug., Sept.
95. A. rhodopolius. *Fr.* Rosy Entoloma. Ground, woods. Aug., Sept.
96. A. costatus. *Fr.* Costate Entoloma. Ground. Sept.
97. A. cuspidatus. *Peck.* Swamps. Sphagnus marshes. Sept.

SUB-GEN. Clitopilus. *Fr.*

98. A. prunulus. *Scop.* Plum Clitopilus. Woods, ground. Season.
99. A. cretatus. *Berk.* Chalky Clitopilus. Woods, ground. Aug., Sept.
100. A noveboracensis. *Peck.* Dingy white Clitopilus. Ground. Aug.
101. A. Woodianus. *Peck.* On ground, and wood. Sept.
102. A. undatus. *Fr.* Waved Clitop. Aug., Sept.

SUB-GEN. Claudopus. *Smith.* Seem. Journal.

103. A. euosmus. *Berk.* Tarragon Clau. Wood. June.
104. A. depluens. *Batsch.* Ground Clau. Ground. Sept.

SUB-GEN. Leptonia. *Fr.*

105. A. chalybæus. *P.* Steel-blue Leptonia. Prairies. July, Sept.
106. A. incanus. *Fr.* Hoary Leptonia. Prairies. Dayton. Aug.

SUB-GEN. Nolanea. *Fr.*

107. A. pascuus. *P.* Pasture Nola. Wet prairies. June.
108. A. rufo-carneus. *Berk.* Red-brown Nola. Marshes. Aug., Sept.
109. A. Babingtonii. *Blox.* Babington's Nola. Woods. Sept.
110. A. conicus. *Peck.* On rotton wood. Swamps. Aug.
111. A. delicatulus. *Peck.* Delicate Nola. Larch swamp. Aug.
112. A. Clintonianus. *Peck.* Clinton's Nola. Swamps. Aug.

SERIES 3. Dermini. *Fr.*

SUB-GEN. Pholiota. *Fr.*

113. A. præcox. *P.* Spring Phol. Prairies. May.
114. A. comosus. *Fr.* Hairy Phol. Decaying trunks. Aug.
115. A. squarrosus. *Mull.* Scaly Phol. Trunks. Aug.
116. A. flammans. *Fr.* Yellow scaly Phol. Ground. June.
117. A. temnophyllus. *Peck.* Brownish Phol. Ground. June, July.

SUB-GEN. Hebeloma. *Fr.*

118. A. punctatus. *Fr.* Ground in woods. Sept.
*119. A. crustuliniformis. Bull.* Ring Hebeloma. Woods. Sept.

120. A. fastibilis. *Fr.* Ochrey Hebe. Woods. July-Oct. Common.
121. A. stellatosporus. *Peck.* Stellate Hebeloma. Ground. Sept.
122. A. griseo cabrosus. *Peck.* Rough Hebeloma. Popple groves. Sept.
123. A. illicitus. *Peck.* Smooth Hebeloma. Popple groves. Sept.
124. A. ascophorus. *Peck.* Viscid Hebeloma. Burned ground. Sept.
125. A. mutatus. *P.* Changeable Hebeloma. Ground. July, Aug.
126. A. pyriodorus. *P.* Pear-scented Hebeloma. Woods. Sept.
127. A. obscurus. *P.* Violet Hebeloma. Ground. July.
128. A. flocculosus. *Berk.* Flocculose Hebeloma. Ground. Sept.
129. A. deglubens. *Fr.* Peeling Hebeloma. Woods. Aug., Sept.
130. A. fastigiatus. *Fr.* Peaked Hebeloma. Woods. July.
131. A. rimosus. *Bull.* Cracked Hebeloma. Ground. June, Sept.
132. A. trechisporus. *Berk.* Rough-spored Hebeloma. Ground. Aug.
133. A. auricomus. *Batsch.* Golden-haired Hebeloma. Woods. July.
134. A. floculentus. *Poll.* Woolly Hebeloma. Ground. July.

SUB-GEN. Flammula. *Fr.*

135. A. polychrous. *Berk.* Reddish Flammula. Ground, wood. Aug., Sept.
136. A. gummosus. *Lasch.* Viscid Flammula. Wood. July.
137. A. sapineus. *Fr.* Bright-Spored Flam. Ground and wood. Aug.

SUB-GEN. Crepidotus. *Fr.*

138. A. mollis. *Schæff.* Soft Crepidotus. On wood. July-Oct.

SUB-GEN. Naucoria. *Fr.*

139. A. semiorbicularis. *Bull.* Half-round Naucoria. Dung. June.
140. A. vernalis. *Peck.* Decaying wood. June.
141. A. lignicola. *Peck.* Decaying wood. June.
142. A. erinaceus. *Fr.* Hedgehog Naucoria. Wood. Nov.

SUB-GEN. Galera. *Fr.*

143. A. ovalis. *Fr.* Oval Galera. Cow-dung. Aug.
144. A. tener. *Schæff.* Slender Galera. Dung. July-Oct.
145. A. sparteus. *Fr.* Meadow Galera. Mossy ground. June.
146. A. hypnorum. *Batsch.* Moss-loving Galera. July, Sept.
147. A. sphagnorum. *Pers.* Bog-moss Galera. July, Sept.

SUB-GEN. Tubaria. Smith. Journ., 1870.

148. A. inquilinus. *Fr.* Little Tubaria. On wood, swamps. June, Sept.
149. A. furfuraceus. *P.* Mealy Tubaria. Chips, wood. July, Sept.

SERIES 4. Praetellæ. *Fr.*

SUB-GEN. Psalliota. *Fr.*

150. A. campestris. *L.* Common Mushroom. Ground. August.
*Var.* pratensis. *Vitt.* Rich muck. Aug.
*Var.* silvicola. *Vitt.* Ramsey and Wright counties. Aug.
151. A. silvaticus. *Schæff.* Wood Psalliota. Woods. Aug.
152. A. Johnsonianus. *Peck.* Woods. Sept.

SUB-GEN. Pilosace. *Fr.*

153. A. eximius. *Peck.* Decaying logs in woods. Sept.

SUB-GEN. Stropharia. *Fr.*

154. A. stercorarius. *Fr.* Dung Stropharia. May, Sept.
155. A. semiglobatus. *Batsch.* Semiglobose Stropharia. June, Sept.

SUB-GEN. Hypholoma. *Fr. Hab.* Generally on stumps.

156. A. sublateritius. *Fr.* Brick-red Hypholoma. Sept.
157. A. fascicularis. *Hud.* Tufted Yellow Hypholoma. Sept.
158. A. lacrymabundus. *Fr.* Weeping Hyph. July, Nov.
159. A. velutinus. *P.* Velvety Hyph. Trunks. July.
160. A. perplexus. *Peck.* Ground about stumps. Sept.
161. A. phyllogenus. *Peck.* Fallen leaves. July

SUB-GEN. Psilocybe. *Fr. Hab.* Mostly on the ground.

162. A. limicola *Peck.* Aug., Sept.
163. A. spadiceus. *Schæff.* Bay Psilocybe. Wood. Ground. Aug.
164. A. cernuus. *Mull.* Nodding Psilocybe. Wood. Ground. Sept.
165. A. fœnisecii. *P.* Brown Psilocybe. Ground. Sept.

SUB-GEN. Psathyra. *Fr. Hab.* Ground. Wood.

166. A. mastiger. *Berk & Br.* Peaked Psathyra. Ground. Aug., Sept.
167. A. corrugis. *P.* Wrinkled Psathyra. Ground. Aug.
168. A. obtusatus. *Fr.* Obtuse Psathyra. Ground. June.

SERIES 5. Coprinarii. *Fr.* Spores black.

SUB-GEN. Panæolus. *Fr.* Mostly on dung.

169. A. separatus. *L.* Ochrey Panæolus. June, Sept.
170. A. leucophanes. *B. & Br.* Shiny-White Panæolus. May, Aug.
171. A. fimiputris. *Bull.* Dark-gray Panæolus. June, Aug.

172. A. campanulatus. *L.* Campanulate Panæolus. June, Aug.
173. A. papilionaceus. *Bull.* Butterfly Panæolus. June, July.
174. A. solidipes. *Peck.* July.
175. A. fimicola. *Fr.* Dung Panæolus. June.

SUB-GEN. Psathyrella. *Fr.*

176. A. gracilis. *Fr.* Slender Psathyrella. Sept.
177. A. pronus. *Fr.* Stooping Psathyrella. Ground. Sept.
178. A. atomatus. *Fr.* Sprinkled Psathyrella. Manure. June, July.
179. A. disseminatus. *Fr.* Clustered Psathyrella. Woods. July, Sept.
180. A. odoratus. *Peck.* Manure heaps. May, June.

GEN. 2. Coprinus. *Fr.*

181. C. comatus. *Fr.* Shaggy Coprinus. Rich ground. Sept.
182. C. atramentarius. *Fr.* Inky Coprinus. Dung. June, July.
183. C. fuscescens. *Fr.* Brownish Coprinus. Wood. June, July.
184. C. picaceus. *Fr.* Magpie Coprinus. Ground. Sept.
185. C. similis. *B. & Br.* Striate Coprinus. Wood. Sept.
186. C. fimetarius. *Fr.* Shaggy-dung Coprinus. June, July.
187. C. tomentosus. *Fr.* Downy Coprinus. Dung. May, June.
188. C. miveus. *Fr.* Snowy Coprinus. May, June.
189. C. micaceus. *Fr.* Glistening Coprinus. May, Sept.
190. C. deliquescens. *Fr.* Deliquescent Coprinus. June.
191. C. lagopus. *Fr.* Hare's foot Coprinus. Dung. July.
192. C. radiatus. *Fr.* Delicate Coprinus. Dung. May, June.
193. C. ephemerus. *Fr.* Ephemeral Coprinus. May, June.
194. C. insignis. *Peck.* About roots of trees. July, Aug.
195. C. angulatus. *Peck.* Ground in woods. Aug., Sept.
196. C. plicatilis. *Fr.* Rich ground. June, July.
197. C. hemerobius. *Fr.* Collared Coprinus. July.
198. C. silvaticus. *Peck.* Ground. Sept.
199. C. semilanatus. *Peck.* Dung. Aug.

GEN. 3. Bolbitius. *Fr.* Manure, rich soil.

200. B. Boltoni. *Fr.* Bolton's Bolbitius. Dung. June, Sept.
201. B. fragilis. *Fr.* Fragile Bolbitius. Epiphytal. May, Aug.
202. B. titubans. *Fr.* Wavering Bolbitius. Ground. Forest. Open. Ju., Oct.
203. B. apicalis. *Smith.* Two-coloured Bolbitius. Ground. June, July.
204. B. nobilis. *Peck.* Noble Bolbitius. Ground. Woods. Sept.

GEN. 4. Cortinarius, *Fr.*

SUB-GEN. 1. Phlegmacium. *Fr.*

205. C. varius. *Fr.* Variable Cort. Ground. Woods. Aug., Sept.

206. C. cyanipes. *Fr.* Blue-stemed Cort. Woods. July, Aug.
207. C. russus. *Fr.* Ruddy Cort. Woods. Sept.
208. C. coloratus. *Peck.* Amongst moss. Larch swamps. Sept.
209. C. communis. *Peck.* Woods. Sept.
210. C. multiformis. *Fr.* Multiform Cort. Woods. Sept.
211. C. glaucopus. *Fr.* Brown-zoned Cort. Sept.
212. C. callochrous. *Fr.* Tawny-viscid Cort. Woods. Aug., Sept.
213. C. cœrulescens. *Fr.* Azure-blue Cort. Woods. Sept.
214. C. turbinatus. *Fr.* Top-shaped Cort. July, Sept.
215. C. scaurus. *Fr.* Club-footed Cort. Woods. Sept.
216. C. corrugatus. *Peck.* Woods. June.

SUB-GEN. 2. Myxacium. *Fr.*

217. C. collinitus. *Fr.* Smeared Cort. Woods. Sept.
218. C. sphærosporus. *Peck.* Woods. Sept.

SUB-GEN. 3. Inoloma. *Fr.*

219. C. violaceus. *Fr.* Violet Cort. Woods. Aug.
220. C. camphoratus. *Fr.* Strong-scented Cort. Ground. Sept.
221. C. callisteus. *Fr.* Stout Cort. Woods. August.
222. C. pholideus. *Fr.* Scaly Cort. Woods. Sept.
223. C. sublanatus. *Fr.* Woolly Cort. Woods. Sept.
224. C. lilacinus. *Peck.* Woods. Sept.
225. C. squamulosus. *Peck.* Scaly Cort. Woods. Aug., Sept.
226. C. asper. *Peck.* Newly cleared places. Sept.

SUB-GEN. Dermocybe. *Fr.*

227. C. anomalus. *Fr.* Thin-capped Cort. Woods. Sept. Oct.
228. C. spilomeus. *Fr.* Scaly-stemmed Cort. Woods. Sept.

SUB-GEN. Telamonia. *Fr.*

229. C. bulbosus. *Fr.* Bulbous Cort. Woods. Aug., Sept.
230. C. lignarius. *Peck.* Decayed wood. June.
231. C. limonius. *Fr.* Lemon Cort. Decaying pine. June.
232. C. hinnuleus. *Fr.* Fawn Cort. Woods. June.
233. C. psammocephalus. *Fr.* Little Tawny Cort. Woods. Aug., Sept.
234. C. ileopodius. *Fr.* Tan-colored Cort. Woods. June, Sept.

SUB-GEN. Hygrocybe. *Fr.*

235. C. Armeniacus. *Fr.* Peach Cort. Woods.
236. C. vernalis. *Peck.* Spring Cort. Ground. June.
237. C. castaneus. *Fr.* Chestnut Cort. Woods. Sept.
238. C. Reedii. *Berk.* Reed's Cort. Shores of lakes. June.

239. C. leucopus. *Fr.* White-stemmed Cort. Woods. May.
240. C. decipiens. *Fr.* Deceptive Cort. Woods. Sept.

GEN. Lepister. *Smith.* Sieem. Jour. 1870.

241. L. nudla. *Bull.* Amethyst Lep. Woods. Prairies. Aug. Sept.
242. L. personata. *Fr.* Purple-stemmed Lep. Ground. Aug. Sept.

GEN. Paxillus. *Fr.*

243. P. involutus. *Fr.* Involute Pax. Ground in woods. Aug. Sept.
244. P. strigosus. *Peck.* Hairy Pax. Ground, woods. Sept.

GEN. Hygrophorus. *Fr.* Terrestrial. Woods, on ground.

245. H. eburenus. *Fr.* Ivory Hygroph. Woods. Sept., Oct.
246. H. cossus. *Fr.* Goat-moth Hygroph. Woods. Sept., Oct.
247. H. cerascinus. *B.* Waxy Hygroph. Woods. Sept., Oct.
248. H. aromaticus. *B.* Aromatic Hygroph. Woods. Sept.
249. H. mesotephrus. *B. & Br.* Brown-disk Hygroph. Woods. Aug.,Sept.
250. H. hypothejus. *Fr.* Pine-wood Hygroph. Sandy soil. Woods. Sept.
251. H. olivaceo-albus. *Fr.* Olive Hygroph. Woods. Sept.
252. H. leporinus. *Fr.* Hare-colored Hygroph. Terrestrial. Sept.
253. H. pratensis. *Fr.* Pasture Hygroph. Open places, woods. Sept.
254. H. niveus. *Fr.* Snow-white Hygroph. Mossy ground. Aug., Oct.
255. H. ceraceus. *Fr.* Wax-like Hygroph. Woods. Sept., Oct.
256. H. miniatus. *Fr.* Vermillion Hygroph. Woods. Aug., Sept.
257. H. coniscus. *Fr.* Conical Hygroph. Terrestrial. Aug., Oct.
258. H. nitidus. *B. & R.* Amongst moss in wet places. Aug., Sept.

GEN. GOMPHIDIUS. *Fr.* Terrestrial mainly.

259. G. viscidus. *Fr.* Viscid Gomphidius. On wood. Aug.

GEN. LACTARIUS. *Fr.* Terrestrial. Mainly in woods.

260. L. torminosus. *Fr.* Woolly Lactarius. Aug., Oct.
261. L. cilicioides. *Fr.* Tomentose Lact. Sept.
262. L. turpis. *Fr.* Dirty Lact. July.
263. L. pubescens. *Schrad.* Pubescent Lact. Aug., Sept.
264. L. zonarius. *Fr.* Zoned Lact. Aug., Oct.
265. L. blennius. *Fr.* Slimy Lact. Aug., Sept.
266. L. pyrogalus. *Fr.* Pear-scented Lact. Aug., Sept.
267. L. plumbeus. *Fr.* Lead-coloured Lact. Aug., Sept.
268. L. chrysorrhæus. *Fr.* Yellow juiced Lact. July, Aug.
269. L. piperatus. *Fr.* Peppery Lact. July, Sept.
270. L. vellereus. *Fr.* Woolly-white Lact. July.
271. L. deliciosus. *Fr.* Delicious Lact. Aug., Oct.

272. L. pallidus. *Fr.* Pallid Lact. Aug., Sept.
273. L. theiogalus. *Fr.* Sulphur-juiced Lact. Aug.
274. L. cyathala. *Fr.* Cup-like Lact. Aug., Sept.
275. L. glyciosmus. *Fr.* Scented Lact. Aug., Oct.
276. L. serifluus. *Fr.* Thin-juiced Lact. Sept.
277. L. fuliginosus. *Fr.* Dingy Lact. July, Oct.
278. L. affinis. *Peck.* Viscid Lact. Sept., Oct.
279. L. volemus. *Fr.* Orange-brown Lact. July, Sept.
280. L. platyphyllus. *Peck.* Aug., Sept.
281. L. sordidus. *Peck.* Sandy soil. Sept.
282. L. griseus. *Peck.* Low ground. Aug.

GEN. Russula. *Fr.* Terrestrial. Usually late Summer and Autumn.

283. R. nigricans. *Fr.* Blackish Rus. July, Aug.
284. R. aduster. *Fr.* Scorched Rus. Sept., Oct.
285. R. delica. *Fr.* Whitish Rus. Woods. Aug.
286. R. furcata. *Fr.* Forked Rus. Woods. Sept.
287. R. sanguinea. *Fr.* Blood-red Rus. Woods. July.
288. R. rosacea. *Fr.* Rosy Rus. Woods. July.
289. R. sardonia. *Fr.* Changeable Rus. Woods. July.
290. R. depallens. *Fr.* Bleached Rus. Woods. July.
291. R. virescens. *Fr.* Greenish Rus. Woods. July, Sept.
292. R. lepida. *Fr.* Scaly Rus. Woods. July, Aug.
293. R. rubra. *Fr.* Red Rus. Woods. July, Aug.
294. R. fœtens. *Fr.* Fœtid Rus. Woods. July, Sept.
295. R. emetica. *Fr.* Emetic Rus. Woods. July, Oct.
296. R. fragilis. *Fr.* Fragile Rus. Woods. July, Aug.
297. R. integra. *Fr.* Entire Rus. Woods. July, Aug.
298. R. decolorans. *Fr.* Discolored Rus. Woods. Sept.
299. R. veternosa. *Fr.* Sleepy Rus.
300. R. nitida. *Fr.* Shining Rus. Woods. Sept.
301. R. alutacea. *Fr.* Tan-colored Rus. Woods. July, Aug.
302. R. lutea. *Fr.* Yellow Rus. Woods. August.
303. R. chamæleontina. *Fr.* Chameleon Rus. Woods. Sept.
304. R. mariæ. *Peck.* Woods. July, Aug.

GEN. Cantharellus. *Adams' Fung.*

305. C. cibarius. *Fr.* Edible Chantarelle. Woods. July.
306. C. aurantiacus. *Fr.* False Chant. Ground and wood. Aug.
307. C. umbonatus. *P.* Umbonate Chant. Ground. July.
308. C. tubæformis. *Fr.* Tubæform Chant. Woods. July.
309. C. infundibuliformis. *Fr.* Funnel-shaped Chant. Ground. July, Aug.
310. C. minor. *Peck.* Ground in woods. July, Aug.
311. C. dichotomus. *Peck.* Damp ground. Woods. July, Aug.

GEN. NYCTALIS. *Fr.* Gen. Hymen.

312. C. asterophora. *Fr.* Star-bearing Nyctalis. Dead Fungi. Sept.

GEN. MARASMIUS. *Fr.* Epiphytal. Terrestrial.

313. M. oreades. *Fr.* Fairy-ring. Champignon. May, Oct.
314. M. fusco-purpureus. *Fr.* Purple brown Maras. Woods. June, July.
315. M. Wynnei. *B. & Br.* Wynne's Maras. Leaves. June, July.
316. M. erythrophus. *Fr.* Pallid Maras. On ground and wood. July.
317. M. terginus. *Fr.* Clustered Maras. In woods-on wood. June.
318. M. alliaceus. *Fr.* Onion-scented Maras. Wood. July, Aug.
319. M. rotula. *Fr.* Collared Maras. Ground. June, Oct.
320. M. androsaceus. *Fr.* Black stemed Maras. June, Sept.
321. M. insititius. *Fr.* Horny stemed Maras. Aug., Oct.
322. M. epiphyllus. *Fr.* Leaf Maras. Woods. June, Oct.
323. M. saccharinus. *Fr.* Granular Maras. Epiphytal. Woods. June, July.
324. M. spodoleucus. *B. & Br.* Stemless Maras. Epiphytal. Woods. June, Sept.
325. M. velutipes. *B. & C.* Woolly Maras. Woods. July.
326. M. plancus. *Fr.* Hairy Maras. Woods. June, Oct.
327. M. subvenosus. *Peck.* Leaves in woods. Aug., Oct.
328. M. campanulatus. *Peck.* Leaves in woods. Aug.
329. M. cæspitosus. *Peck.* Decaying branches, woods. June.
330. M. longipes. *Peck.* Among fallen leaves, woods. Aug., Oct.
331. M. glabellus. *Peck.* Amongst leaves, woods. July, Sept.
332. M. anomalus. *Peck.* Sticks, leaves in woods. July.

GEN. Lentinus. *Fr.* Generally on wood.

333. L. tigrinus. *Fr.* Tiger-spot Len. June, Oct.
334. L. Dunalii. *Fr.* Dunal's Len. June, Sept.
335. L. lepidius. *Fr.* Scaly Len. June, July.
336. L. cochleatus. *Fr.* Shell Len. June, July.
337. L. vulpinus. *Fr.* Strong-scented Len. May, Aug.

GEN. Panus. *Fr.* Epiphytal. Stumps.

338. P. torulosus. *Fr.* Twisted Pan. Sept.
339. P. conchatus. *Fr.* Shell Pan. May, Oct.
340. P. salicinus. *Peck.* On Salix discolor. Michx. Sept., Oct.
341. P. strigosus. *B. & C.* Aug.

GEN. Trogia. *Fr.*

342. T. crispa. *Fr.* Crisped Trogia. On dead branches. Sept

GEN. Schizophyllum. *Fr.*

343. S. commune. *Fr.* Common Schiz. On dead wood. The season.

### Gen. Lenzites. *Fr.*

344. L. betulina. *Fr.* Birch Lenzites. Stumps. Perennial.
345 L. floccida. *Fr.* Flaccid Lenzites. Stumps. Sept., Oct.

## Order II. Polyporei.

### Gen. Boletus. *Fr.* Terrestrial.

346. B. elegans. *Schum.* Elegant Boletus. Woods. June, Oct.
347. B. flavus. *With.* Bright-yellow Bolet. Woods. July.
348. B. badius. *Fr.* Bay Boletus. Woods. Wright county. August.
349. B. striæpes. *Sec.* Striate Bolet. Aug.
350. B. chrysenteron. *Fr.* Red-cracked Bolet. Sept.
351. B. subtomentosus. *L.* Yellow-cracked Bolet. Woods. Aug.
352. B. pachypus. *Fr.* Thick-stemmed Bolet. Aug., Sept.
353. B. edulis. *Bull.* Edible Bolet. Woods. Aug.
354. B. æstivalis. *Fr.* Early Bolet. Woods. Esculent.
355. B. purpureus. *Fr.* Purple Bolet. Woods. Aug.
356. B. scaber. *Fr.* Shaggy Bolet. Woods. Aug. Esculent.
357. B. alutarius. *Fr.* Tan-colored Bolet. Woods. Aug.
358. B felleus. *Bull.* Bitter Bolet. Woods. Sept.
359. B. cyanescens. *Bull.* Sibthorp's Bolet. Woods. Aug.

### Gen. Polyporus. *Fr.*

360. P. leptocephalus. *Fr.* White-pored Poly. On wood. June, July.
361. P. perennis. *Fr.* Perennial Poly. Ground, stumps. Aug., Oct.
362. P. Rostkovii. *Fr.* Rostkovius' Poly. Rotton wood. June, Sept.
363. P. elegans. *Fr.* Elegant Poly. Trunks, branches, woods. July.
364. P. quercinus. *Fr.* Oak Poly. Old oaks. June.
365. P. sulfureus. *Fr.* Sulphury Poly. Logs, stumps. June, Sept.
366. P. alligatus. *Fr.* Connected Poly. Base of stumps. June, Sept.
367. P. heteroclitus. *Fr.* Grand Poly. Ground Wright county. Aug.
368. P. salignus. *Fr.* Willow Poly. On Willows. July, Nov.
369. P. chioneus. *Fr.* Soft white Poly. Roots of stumps. Aug.
370. P. cassius. *Fr.* Blue-gray Poly. On pine logs. July, Oct.
371. P. destructus. *Fr.* Destructive Poly. Larch, ground. July, Sept.
372. P. rutilans. *Fr.* Reddish Poly. Branches, woods. June.
373. P. adustus. *Fr.* Scorched Poly. Stumps.
374. P. hispidus. *Fr.* Hispid Poly. Living oaks. Perennial.
375. P. spumeus. *Fr.* Oozing Poly. Trunks, branches. July.
376. P. nigricans. *Fr.* Black-hoof Poly. Living birch. Perennial.
377. P. annosus. *Fr.* Imbricated Poly. Larch stumps. Perennial.
378. P. connatus. *Fr.* Connate Poly. Crab trunks. Miss R. A. Johnson.
379. P. hirsutus. *Fr.* Bristly Poly. Dead trunks. Woods. July.
380. P. versicolor. *Fr.* Common Zoned Poly. Stumps, &c. Persistent.

381. P. abietinus. *Fr.* Whitish Fir Poly. Larch. July.
382. P. contiguus. *Fr.* Contiguous Poly. Decayed wood, &c. June, Sep.
383. P. ferruginosus. *Fr.* Rusty Poly. Posts, &c. June, Sept.
384. P. Armeniacus. *Berk.* Buff Fir Poly. June.
385. P. incarnatus. *Fr.* Flesh-Colored Poly. Larch. July, Aug.
386. P. violaceus. *Fr.* Violet Poly. Poplar Larch. July, Aug.
387. P. medulla-panis. *Fr.* Crumb of Bread Poly. Wood. June, Sept.
388. P. obducens. *Fr.* Incrusting Poly. Rotten wood. Perennial.
389. P. vulgaris. *Fr.* Common-effused Poly. Dead wood.
390. P. vaporarius. *Fr.* Creeping Poly. Fallen branches.
391. P. glomeratus. *Peck.* On Acer saccharinum. *Wang.* Aug.
392. P. Gordoniensis. *B. & Br.* Gordon's Fir Poly. Decaying wood. Sep.

GEN. Trametes. *Fr.*

393. T. pini. *Fr.* Fir trunk Trametes. Pine trunks. Perennial.
394. T. odora. *Fr.* Small pored Trametes. Willows.

GEN. Dædalea. *Fr.*

395. D. unicolor. *Fr.* One-coloured Dædalea. Stumps. Trunks.
396. D. latissima. *Fr.* Effused Dædalea. On fallen dead branches.

GEN. Merulius. *Fr.*

397. M. tremellosus. *Schrad.* Tremellose Merulius. Sept.
398. M. corium. *Fr.* Leathery Merulius. Dead trunks.
399. M. malluscus. *Fr.* Thin Merulius. Dead wood.
400. M. rufus. *P.* Rufous Merulius. Dead oak branches.
401. M. serpens. *Fr.* Creeping Merulius. Dead wood. June, Sept.

GEN. Porothelium. *Fr.*

402. P. Friesii. *Mont.* Fries' Porothelium Pine wood.

ORDER III. Hydnei.

GEN Hydnum. *Linn.*

403. H. repandum. *L.* Spreading Hyd. Ground. Aug., Sept.
404. H. zonatum. *Batsch.* Zoned Hyd. Ground. Woods. Sept.
405. H. tomentosum. *L.* Tomentose Hyd. Ground. Woods. July.
406. H. erinaceus. *Hull.* Hedgehog Hyd. Living Oak. Sept., Oct.
407. H. niveum. *P.* Snowy Hyd. Dead wood. Leaves. Sept.
408. H. farinaceum. *P.* Mealy Hyd. Decaying wood. July, Sept.

ORDER IV. Auricularini. *Fr.*

GEN. Cratorellus. *Fr.*

409. C. cornucopioides. *Fr.* Horn-like Cratellus. Ground.

Gen. Thelephora. *Fr.*

410. T. cæsia. *P.* Ash-gray Thelephora. Incrusting grass.
411. T. arida. *Fr.* Dry Thelephora. Decaying pine.

Gen. Stereum. *Fr.*

412. S. purpureum. *Fr.* Purple Stereum. Trunks. Perennial.
413. S. hirsutum. *Fr.* Hairy Stereum. Stumps. Peren.
414. S. acerinum. *Fr.* Maple Stereum. Living maple trunks.

Gen. Hymenochæte. *Lev.*

415. H. rubiginosa. *Lev.* Rubiginous Hymenochæte.

Order V. Clavarici.

Gen. Clavaria. *L.*

416. C. amethystina. *Bull.* Amethyst Clavaria. Sept.
417. C. fastigiata. *D. C.* Fastigiate Clavaria. Woods. Aug., Oct.
418. C. coralloides. *L.* White Coral Clavaria. Woods. Aug., Sept.
419. C. umbrina. *Berk.* Umber Clavaria. Woods. Aug., Sept.
420. C. cinerea. *Bull.* Cinereous Clav. Woods. Sept.
421. C. cristata. *Holmsk.* Crested Clav. Woods. Sept.
422. C. rugosa. *Bull.* Wrinkled Clav. Woods. Sept.
423. C. Kunzei. *Fr.* Kunze's Clav. Woods. Sept.
424. C. aurea. *Schæff* Golden Clav. Open woods. Sept.
425. C. formosa. *Pers.* Beautiful Clav. Aug., Oct.
426. C. crocea. *P.* Saffron-yellow Clav. Decaying wood. May.
427. C. purpurea. *Mull.* Purple Clav. Woods. Sept.
428. C. inæqualis. *Mull.* Unequal Clav. Woods. Sept.
429. C. vermiculata. *Scop.* White-tufted Clav. Aug., Sept.
430. C. fragilis. *Holmsk.* Brittle Clav. Woods. Sept.
431. C. contorta. *Fr.* Contorted Clav. Branches. Aug.

Gen. Calocera. *Fr.*

432. C. glassoides. *Fr.* Soft Calocera. Decayed stumps. Sept.

Order VI. Tremellini.

Gen. Tremella. *Fr.*

433. T. fimbriata. *Pers.* Fringed Tremella. Dead branches. June.
434. T. frondosa. *Fr.* Large Pale Tremella. Ground. Aug., Oct.
435. T. foliacea. *P.* Foliaceous Tremella. Stumps. Aug.
436. T. lutescens. *Fr.* Yellowish Tremella. Old stumps. Aug., Sept.
437. T. mesenterica. *Retz.* Orange Tremella. Sticks. Aug., Oct.

438. T. vesicaria. *Bull.* Bladdery Tremella. Ground. Aug., Sept.
439. T. albida. *Hud.* Whitish Tremella. Logs. June, Aug.
440. T. intumescens. *Sow.* Contorted Tremella. Wood. July, Sept.
441. T. indecorata. *Somm.* Dingy Tremella. Dead willows. Aug.
442. T. tubercularia. *Berk.* Horny Tremella. Branches. Sept., Oct.
443. T. torta. *Willd.* Twisted Tremella. Oak. July, Sept.
444. T. epigæa. *B. & Br.* Ground Tremella. Ground. Sept.

Gen. Exidia. *Fr.*

445. E. glandulosa. *Fr.* Witches'-Butter Exidia. Oak branches. Aug.

Gen. Hirneola. *Fr.*

446. H. Auricula-Judae. *Berk.* Jew's-ear Hirneola. Wood.

Gen. Dacrymyces. *Nees.*

447. D. stillatus. *Nees.* Orange Dacrymyces. Pine logs.

Gen. Apyrenium. *Fr.*

448. A. lignatile. *Fr.* Wood loving Apyrenium. Decayed wood.

HYPOGÆI.

Family II Gasteromycetts.

Order VII. Hypogæi.

Gen. Hymenogaster. *Tul.*

449. H. muticus. *B. & Br.* Cracking Hymenogaster. Sept.
450. H. luteus. *Vitt.* Yellow Hymenogaster. Woods. July, Sept.
451. H. decorus. *Tul.* Comely Hymenogaster. Woods. Aug. Sept.

PHALLOIDEI.

Order VIII. Phalloidei.

Gen. Phallus. *Linn.*

452. P. impudicus. *Linn.* Common Stink-horn. Sept., Oct.

TRICHOGASTRES.

Order IX. Trichogastres.

Gen. Tulostoma. *Pers.*

453. T. mammosum. *Fr.* Nippled Tulostoma. Ground.

GEN. Geaster. *Mich.*

454. G. fornicatus. *Fr.* Vaulting Geaster. Ground. Sept., Oct.
455. G. striatus. *D. C.* Striate Geaster. On sand.
456. G. Bryantii. *Berk.* Bryant's Geaster. Sandy soil.
457. G. hygrometricus. *P.* Hard-coated Geaster. Ground. Woods. Oct.
458. G. lageniformis. *Vitt.* Flask-like Geaster. Woods. Oct.

GEN. Bovista. *Dill.*

459. B. nigrescens. *P.* Blackish Bovista. Prairies. May.
460. B. plumbea. *P.* Lead-colored Bovista. Prairies. Common.
461. B. ammophila. *Lev.* Rooting Bovista. Woods. Sept.

GEN. Lycoperdon. *Tourn.*

462. L. giganteum. *Batsch.* Giant Puff-ball. Pastures. Oct.
463. L. cælatum. *Fr.* Collapsing Puff-ball. Prairies. Aug., Sept.
464. L. atropurpureum. *Vitt.* Purple-spored Puff-ball. Aug.
465. L. pusillum. *Fr.* Little Puff-ball. Prairies. June, Sept.
466. L. saccatum. *Vahl.* Elongated Puff-ball. Thickets. July.
467. L. gemmatum. *Fr.* Warted Puff-ball. Meadows. Prairies. Aug.
468. L. pyriforme. *Schœff.* Pear-shaped Puff Ball. Stumps. Sept.

GEN. Scleroderma. *P.*

469. S. vulgare. *Fr.* Common Scleroderma. Borders of woods. Aug.
470. S. bovista. *Fr.* Thin-coated Scleroderma. Aug., Sept.
471. S. verrucosum. *Pers.* Warty Scleroderma. Prairies. Aug.

GEN. Polysaccum. *D. C.*

472. P. olivaceum. *Fr.* Olive Polysaccum. Ground, woods. Aug.

ORDER X. Myxogastres.

GEN. Lycogala. *Mich.*

473. L. epidendrum. *Fr.* Stump Lycogala. July, Oct.

GEN. Reticularia. *Bull.*

474. R. maxima. *Fr.* Large Reticularia. Trunks, fallen trees.
475. R. atra. *Fr.* Black Reticularia. Pine logs. Aug.
476. R. umbrina. *Fr.* Umber Reticularia. Stumps. July.

GEN. Æthalium. *Link.*

477. A. septicum. *Fr.* Æthalium. Woods. Decaying wood.

GEN. Spumaria. *Fr.*

478. S. alba. *D. C.* White Spumaria. Living grass. June.

GEN. Ptychogaster. *Ca.*

479. P. albus. *Corda.* White Ptychogaster. On ground. July.

GEN. Diderma. *P.*

480. D. farinaceum. *Peck.* Invests fern stems in low woods.
481. D. Mariae-Wilsoni. *Clinton.* Sticks, woods. Aug.
482. D. globosum. *Fr.* Globose Diderma. Dead leaves. Sept.

GEN. Didymium. *Schrad.*

483. D. melanopus. *Fr.* Black-stemmed Didymium. Sticks. Aug.
484. D. connatum. *Peck.* Decaying *Russula.* Sept.
485. D. furfuraceum. *Fr.* Scurfy Did. Rotten wood. July, Aug.
486. D. squamulosum. *A. & G.* Scaly Did. Dead leaves, &c. Aug.
487. D. farinaceum. *Fr.* Mealy Did. Dead leaves. Aug.
488. D. pertusum. *Berk.* Pierced Did. Stumps. Oct.

GEN. Physarum. *P.*

489. P. pulcherripes. *Peck.* Rotten wood. July.
490. P. cæspitosum. *Peck.* Rotten wood. Aug.
491. P. atrum. *Fr.* Black Physarum. Dead Branches. Aug.

GEN. Angioridium. *Grev.*

492. A. sinuosum. *Grev.* Twisted Angioridium. Sept.

GEN. Craterium. *Trent.*

493 C. mutabile. *Fr.* Changeable Craterium. Bark. July.

GEN. Diachæa. *Fr.*

494. D. elegans. *Fr.* Elegant Diachæa. Dead leaves. Aug.

GEN. Stemonitis. *Gled.*

495. S. fusca. *Rath.* Brown Stemonitis. Dead wood. June.
496. S. ferruginea. *Ehrb.* Rusty Stemonitis. Dead wood. July.
497. S. ovata. *P.* Ovate Stemonitis. Rotten wood. June.
498. S. obtusata. *Fr.* Obtuse Stemonitis. Rotten wood. June.

GEN. Arcyria. *Hill.*

499. A. nutans. *Fr.* Nodding Arcyria. Rotten wood. June.

ORDER XI. Nidulariacei. *Tul.*

GEN. Polyangium. *Link.*

500. P. vitellinum *Ditm.* Egg-yellow Polyangium. Stumps.

FAMILY III. Coniomycetes.

ORDER XII. Sphaeronemei.

GEN Phoma. *Fr.*

501. P. ampelinum. *B. & C.* Dead grape vines. Woods. July.
502. P. exiguum. *Desm.* Little Phoma. Elder shoots. Aug.
503. P. glandicola. *Lev.* Acorn Phoma. Acorns. Sept.

GEN. Discella. *B. & Br.*

504. D. carbonacea. *B. & Br.* Black Discella. Dead twigs.

ORDER XV. Pucciniæi.

GEN. Phragmidium. *Link.*

505. P. mucronatum. *Link.* Rose Brand. Living Rose leaves. Aut.
506. P. gracile. *Greve.* Raspberry Brand. Rasp. leaves. Aut.
507. P. obtusum. *Link.* Strawberry Brand.
508. P. graminis. *Pers.* Corn mildew. Leaves of corn. Aut.
509. P. striola. *Link.* Sedge Mildew. Rushes. Autumn.
510. P. coronata. *Corda.* Coronated Mildew. Grasses.
511. P. vaginalium. *Link.* Knot-grass Brand Aut.
512. P. primulae. *Grev.* Primrose Brand. Primroses. June.
513. P. variabilis. *Grev.* Variable Brand. Taraxacum. July.

GEN. Gymnosporangium. *D. C.*

514. G. juniperi. *Lk.* Living branches.

ORDER XVI. Cæomacei.

GEN. Tilletia. *Tul.*

515. T. caries. *Tul.* Bunt. On wheat filling the grains. Aut.

GEN. Ustilago. *Link.*

516. U. carbo. *Tul.* Corn smut. Autumn.
517. U. antherarum. *Fr.* Anther Smut. Lychens, &c.
518. U. violae. *B. & Br.* Violet Smut. Violet leaves. August.
519. U. occulta. *Preus.* Rye smut. On culms of rye.

GEN. Uredo. *Lev.*

520. U. Quercus. *Brand.* Oak-leaf Uredo. Sept.
521. U. bifrons. *Grev.* Twin-faced Uredo. On *Rumex.* Aug., Sept.

ORDER XVII. Æcidiacei.

GEN. Æcidium. *Pers.*

522. A. euphorbiæ. *Pers.* Spurge Cluster-Cups. May, June.
523. A. urticæ. *D. C.* Nettle Cluster-Cups. June.

FAMILY IV. Hyphomycetes.

ORDER XVIII. Isariacei.

GEN. Isaria. *Fr.*

524. I. arachnophila. *Ditm.* Spider Isaria. Dead spiders.
525. I. citrina. *P.* Lemon-colored Isaria. Decaying fungi. Aug.
526. I. intricata. *Fr.* Intricate Isaria. Decaying fungi. Sept.

ORDER XIX. Stilbacei.

GEN. Tubercularia. *Tode.*

527. T. granulata. *P.* Granulate Tubercularia. Dead branches.

DIVISION II. Sporidiifera.

FAMILY VI. Physomycetes.

ORDER XXIV. Mucorini.

GEN. Ascophora. *Tode.*

528. A. elegans. *Corda.* Elegant Ascophora. Fowls' dung.

GEN. Mucor. *Mich.*

529. M. ramosus. *Bull.* Branched Mucor. Decaying fungi. Aug.
530. M. Mucedo. *L.* Common Mucor. Decaying fruits.
531. M. caninus. *P.* Dog's dung Mucor. Dung of dogs.

## Family VII. Ascomycetes.

### Order XXVIII. Elvellacei.

#### Gen. Morchella. *Diel.*

582. M. esculenta. *Pers.* Common Morel. Woods. May, June.

#### Gen. Helvella. *Linn.*

583. H. gigas. *Kromb.* Large Helvella. Ground, woods. Spring.
584. H. crispa. *Fr.* Pallid Helvella. Ground, woods. Early Summer.
585. H. sulcata. *Afz.* Sulcate Helvella. Ground, woods. Oct.

#### Gen. Verpa. *Swartz.*

586. V. digitaliformis. *Pers.* Finger-shaped Verpa. Wood.

#### Gen. Spathularia. *P.*

587. S. flavida. *Prs.* Yellow Spathularia. Woods. July.

#### Gen. Leotia. *Hill.*

588. L. lubrica. *Pers.* Slimy Leotia. Woods. Sept.

#### Gen. Geoglossum. *P.*

589. G. viride. *P.* Green Geoglossum. Decayed wood.
540. G. glutinosum. *P.* Glutinous Geoglossum. Woods.

#### Gen. Peziza. *Linn.*

541. P. macropus. *Pers.* Long-stemmed Peziza. Ground. July.
542. P. badia. *P.* Large Brown Peziza. Pond margin. July.
543. P. aurantia. *Fr.* Orange Ground Peziza. June.
544. P. lutea-nitens. *B. & Br.* Bright Yellow Peziza. Ground.
545. P. fibrillosa. *Curr.* Woolly Orange Peziza. Oct.
546. P. repanda. *Wahl.* Spreading Peziza. Gound. June.
547. P. trachycarpa. *Curr.* Rough-spored Peziza. Woods.
548. P. leiocarpa. *Curr.* Smooth-spored Peziza. Ground.
549. P. cupularis. *L.* Scolloped Peziza. June.
550. P. subhirsuta. *Schum.* Hirsute Peziza. Ground.
551. P. humosa. *Fr.* Ground Peziza. Woods.
552. P. scutellata. *L.* Shield-like Peziza. Woods. May, Sept.
553. P. unicisa. *Peck.* Ground in woods. Sept., Oct.
554. P. echinosperma. *Peck.* Ground in woods. June.
555. P. rubra. *Peck.* Burnt ground. June.
556. P. tiliae. *Peck.* Dead branches. Tilia Americana. July.
557. P. coccinea. *Jacq.* Carmine Peziza. Wood. Nov.

ORDER XXXI. Sphæriacei.

GEN. Valsa. *Fr.*

558. V. pulchella. *Fr.* Beautiful Valsella. Cherry and birch.

With three or four exceptions, the plants constituting the foregoing list of *Fungi*, have been found by the writer.

Respectfully contributed,

A. E. JOHNSON.

MINNEAPOLIS, January 1st, 1877.

# VI.

# ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

*Prof. N. H. Winchell:*

In accepting the position of Ornithologist on the Geological and Natural History Survey of the state to which I have been appointed by the Board of Regents, I desire to express to you and the Board my appreciation of the honor thus conferred upon me.

When first proposed to me to undertake this work, its objects were so accordant with my inclinations that I had only to harmonize its requirements with the exacting duties of my profession, to enter enthusiastically upon it. This our mutual arrangements have enabled me to do more satisfactorily than I had hoped. I therefore permit myself to expect to have something to report to you at the end of another year appropriate to an embodiment in the permanent records of your comprehensive work.

To do this I must be permitted to rely upon the co-operation of not only yourself and the other members of your staff, but of the Board, and all collectors temporarily or permanently associated with the survey.

I have had sufficient experience in the work before me to realize the necessity of aid from reliable sources, and this department of your survey has been so long delayed that it must be rigorously prosecuted if it shall keep its place alongside of the others in the years to come. I do not commence it, however, entirely *de novo*, having had some nineteen years observations in which I have accumulated some notes on birds in my vicinity, with occasional explorations into other sections as fully represented by them. The rapid settlement of the state has changed the relative representation of this class of its fauna very materially, and the increasing extent of the cultivation of the soil for varied productions is at present not only changing the aggregate numbers of birds that come here to breed, and those that permanently reside here, but

the relative proportions of species, which shows the importance of early attention to this department of the zoology of the state.

The earliest information on this subject that I have been able to get has been obtained through interviews with persons connected with the army or trappers and traders, stationed at the several military posts at a very early day. Of course this has been meagre, and unsatisfactory because, to a large extent, it has been unreliable. After sifting it as carefully as possible I find about fifty to sixty species that are known to be territorial and aboriginal.

The first approximation towards a listing of species was made by Henry Patton in connection with Owen's geological survey of Wisconsin, Iowa and Minnesota, in 1848–9. As he did not record the locality, or any of the circumstances of his observations, his list I regret to say is but little more valuable than the foregoing, as it is impossible to ascertain what portion of the ninety-five species he gives were obtained within our own special province. It is not a little remarkable that in the several explorations by the national government preliminary to the location of our great transcontinental railroad, made upwards of twenty years ago, while ample provisions were made for collecting the birds along the various lines of exploration in every other instance, that from St. Paul to the Rocky Mountains had none. From thence to the Pacific the collections were as abundant and the reports as full as on any other route embraced in these extensive explorations. But in subsequent railroad surveys—in 1870,I think,—along the line of the Northern Pacific, Mr. Tripp reported a list of 138 species observed, which only recently came to my notice in the Proceedings of the Essex Institute of Massachusetts. Excepting the few mentioned, my own notes of observation, published by the Minnesota Academy of Natural Sciences in 1874, had antedated them so far as this section was involved.

There have been occasional observations noted by persons visiting or passing through the state, which have been preserved, that are reliable.

During the last year—1876—several species hitherto unknown here have been identified, making at the present time a list of about two hundred and seventy-five species, embracing one hundred and sixty-one genera, in thirty-eight families under six orders.

This comprises nearly the entire history of the ornithology of Minnesota, up to the present time, so far as my knowledge extends.

Very respectfully yours,

P. L. Hatch.

Minneapolis, Jan. 10, 1877.

# VII.

# ENTOMOLOGY.

## REPORT OF ALLEN WHITMAN.

SAINT PAUL, MINNESOTA,
December 23d, 1876.

*Prof. N. H. Winchell, State Geologist:*

SIR:—I have the honor to present the following report upon the Rocky Mountain Locust,* as it has appeared in and near Minnesota during the year 1876. At the time of my appointment (in May) to make this report, through the State Geological Survey, there was a hope, and apparently a reasonable one, that the coming summer would close our present opportunities for observing the destructive species of locust, at least as far as our state was concerned. The insects were found to be hatching in a region covering the whole or parts of five or six of our southwestern counties, in a strip of country reaching from Madelia westward

* The name "Rocky Mountain Locust" is expressed or implied throughout this report. I suppose that every one knows that it is the *Caloptenus Spretus*, or the "grasshopper," that is referred to. Although the name "hopper" holds its place in popular usage, by force of its brevity and euphony, the use of the word locust can occasion no ambiguity, at least in Minnesota. In regard to the latter name, an old etymology is still often repeated, which has done duty long enough. The word *locust* (Latin, *locusta*,) is not derived from the Latin *locus-ustus*, a *burnt place*, and that for half a dozen reasons. The root of the word (*loc*) is probably found in the Greek root *lak* (in *lasko*, *e-lak-on*,) and in the Latin *loqu-or*, referring in this case to the chirping or shrilling sound of some insect called *locusta*. Its form is confirmed by such Latin words as *robustus*, *venustus*, &c See *Fick, Vergleichendes Woerterbuch der Indogermanischen Sprachen. Part IV. Root* (8.)

across the state, and into two of the eastern counties of Dakota. A few were also found in the northern part of the state in Clay county, and in a few scattered spots in Dakota along the Red river. No other hatching-ground nearer than Colorado was known, and there was reason to believe that the amount of damage resulting from their presence here would be comparatively small, and a fair probability that their swarms would be so scattered and so diminished during the summer, that the injury would, for the present, end with the flying season. Under these circumstances, it seemed best to make such additions and corrections to the Report of the Grasshopper Commission of 1875, as the experience of the present year should furnish. But as the season has advanced, and events have multiplied themselves, the subject has assumed, both in extent and urgency, a new and continued importance. Following close upon the attack of 1874, we have a new locust invasion, surpassing all former ones in the amount of territory visited, in the magnitude of the invading swarms, in their repeated comings, and in the length of their combined stay. In addition to the losses inflicted upon the crops during the last four summers, amounting to at least eight millions of dollars, we find the evil still confronting us as in 1873, and while we have gained something by our four years' experience, we have also lost something by the disheartenment which four successive years of damage necessarily bring. To meet in any such report as this the demands of a subject so extensive and important, or the expectations of the large number of people who are so deeply interested in it would be simply an impossibility, but I should be glad if anything contained in it could add to the knowledge necessary for intelligent action, or to the hopefulness which we may reasonably entertain in regard to the locust problem in the long run. Such as it is, the report is the result of several visits to the southwestern counties during the spring and summer, of replies to circulars sent to nearly every infested town in the state, and of a large amount of correspondence addressed freely to various points in Minnesota, Dakota, and elsewhere. To compile such information as could be collected from all these, and from hundreds of items published in our state papers during the summer, has been a work of a good deal of time and trouble. The practical value of the results of work of this kind seldom corresponds to the amount of trouble incurred, but this is simply the fault of the subject.

### GENERAL VIEW OF LOCUST INVASIONS.

Taking into consideration the whole cultivated region from

Manitoba to Texas and from the Rocky Mountains to the Mississippi, there have been in the series of thirteen years from 1864 to 1876, but four, (or at most five) years when some portion of this area was not attacked by locusts, coming in from somewhere outside of the cultivated area. In other words there have been no less than nine locust invasions, (differing much in extent and degree, but still occurring,) in the Mississippi and Red River valleys during the last thirteen years. And these nine attacks stand against some seven or eight recorded appearances of destructive locusts in the same territory during the 46 years preceding, from 1818 to 1864. Again we have on the one hand the sudden appearance of the immense swarms which are said to have overrun a vast extent of territory on both sides of the Rocky Mountains in 1855, the gradual disappearance of their progeny in the course of the next three years, apparently without furnishing material for subsequent invasions, and their continued absence for the next six years. On the other hand we have, since 1864, a series of attacks occurring at intervals of one, two, or at most three years, and apparently of late an annual vibration between the country lying along the mountains and the lower cultivated regions, each in its turn becoming a breeding-ground. The causes of the increase and continuance of the evil of late years lie outside the range of common observation. That they do not result entirely from an increase of acreage under cultivation, is to be inferred from the locust history of other countries, and from the facts that while Central America has suffered from the same evil at least as far back as 1514 (Bancroft's Native Races of the Pacific Coast, vol. v., page 601,) and Mexico and California at least as lately as 1855, the exemption of these countries since the latter date has been as noticeable as the repeated devastation of our own vicinity. As for any analogy to be derived from the locust history of European countries the books are not at hand in this state to furnish the exact chronology of the evil; but from such a source as I have at hand, the record of Germany for the last four centuries shows intervals of exemption from injury for eight, twelve, sixteen, forty (1763—1803,) or even fifty (1636—1686) years, and again no less than fourteen years of injury between 1727 and 1755, and among these series of three, four, or even five successive years of damage, as in the five years from 1727 to 1731, and again from 1746 to 1750.*

* These dates are taken from a work entitled, Die Kleinen Feinde der Landwirthschaft, by Prof. H. Nordlinger, Stuttgard, 1855, furnished by the kindness of Gustav Kyllander, Esq., of Severance, Sibley county. For a

The locust problem still presents a great deal upon which nothing like complete information has been furnished. Even in regard to the locust as it appears in our own State, not only does the farmer ask many questions, to which the entomologist can as yet give no decisive answer, but even in the practical economy of the locust question opinions are still at variance, where experience should, by this time, have brought some degree of unanimity. When it comes to the exact origin of our invading swarms, their manner of increase from year to year before leaving their native regions, their growth, habits, and movements in those regions, how far eastward those regions may or do extend, the causes of the repeated appearance of migrating swarms, or their continued absence for years or even decades, no one can at present offer in answer much more than a mere show of probabilities. It is evident that the whole question is becoming too urgent to wait for private investigation to solve it. The claims which an agricultural population of at least thirteen States and Territories may justly urge upon the National Government in this regard, have been fully set forth during the past season ; but purely in the interest of science, if for no other reason, we might fairly ask that some portion of the sums annually devoted to national discovery might be expended upon the further elucidation of a subject which touches us so nearly and so powerfully. Having at hand the time, the place, and the opportunity, we might at least attempt the solution of some questions which the Old World has been obliged to leave unanswered for a thousand years. We might, perhaps, learn enough of the causes of locust invasions to know in what years such invasions would become probable, and enough of their origin to say whether prevention is possible or impossible.

### THE EVIL AS IT APPEARS IN MINNESOTA.

The growth and habits of the young locust as it appears in the cultivated regions, have been so fully described of late years, (particularly in the seventh and eighth annual reports of the State Entomologist of Missouri, Prof. Ch. V. Riley,) that it seems im-

systematic and connected view of the locust evil in general see a paper contained in the Report (for 1876) of the Hon. Commissioner of Statistics of Minnesota, Dr. J. B. Phillips. Notice is particularly called to a chronological table published therein. It will be seen that there is no state or territory west of the Mississippi that is not in the "grasshopper regions," and no year since 1863 that has not been a locust year. The year 1871 should be included in the table, for reasons stated in this report.

possible to add much that can contribute to that practical end which the farmer has in view, the protection of his crops from the locusts which hatch in his immediate vicinity. If anything practical is still to be expected in this direction it ought to come from those who are brought face to face with the young locust, and are obliged to act upon knowledge gained upon the spot. Enough has been learned already to make it certain that almost any community may, by enlisting all the forces at its disposal, effect a measurable saving of its crops, and that the evil, if it could be confined to the locusts that hatch here, might be practically eradicated in a few years at most. But there is a growing apprehension in the minds of the people of Minnesota, brought about mostly by a consideration of events occurring in our own state only, and that too only within the last four years, that we are more liable to locust invasions than other states; that the locust evil may become a permanent one here even without reinforcements from abroad, and that its area may gradually extend until it covers regions still unknown to it. This apprehension is increased by the fact that the invasion of the present year has reached, (to the south of St. Paul,) about one degree of longitude farther east than it has ever been known to extend before. It is possible that Minnesota may, from its geographical position, suffer from locust invasions more frequently in the long run of fifty or a hundred years than Kansas or Manitoba, though a history of the last twenty years shows no special preponderance in favor of either state; it is possible that its cold climate, and the high and dry soil of its southwestern counties may furnish a more congenial and permanent home to the swarms that breed here, though the events of the last four years, when fairly considered, show that even here there is a constant decrease in the numbers of such swarms as remain; and finally the history of the whole Mississippi Valley shows that the Rocky Mountain Locust is confined on the east by a tolerably well defined limit which up to the present time, neither invading swarms, nor their progeny have essentially altered. Upon all these points entomologists are repeatedly called to express their opinions, which have been freely and in most cases cautiously given; and these opinions are in turn repeatedly called into question by those who persist in mistaking opinion for prophecy, or in applying a general rule to a limited area, or to a particular year. But it is evident that there is still room for the study of the physical character of the locust, and of the geographical, geological, climatic or other causes by which it is influenced.

HISTORY OF PAST INVASIONS.

Until within the last four years the migratory species of locusts has been so infrequent and transient a visitor in Minnesota, that the details of its former visits are almost forgotten. There is no definite knowledge of any such visit down to the year 1855, unless the ravages committed in the Red River Settlement in 1818 and 1819 may be said to concern this State. But the statement of Capt. Jonathan Carver in 1766, in regard to the large swarms which "infest these parts and the interior colonies" shows the occasional presence of the migratory locust, although it is hard to say exactly what localities are referred to. But late in July, 1856, invading swarms came from the Northwest into the Upper Mississippi Valley, and gradually spread along the river during the season, much the same as they have done in the past summer, and reaching nearly the same limits. The injury was, of course, felt most severely along the Mississippi and the cultivated region adjacent, but the locusts are said to have appeared along the Minnesota River, in the Yellow Medicine country, and at various points in the northwestern counties of the State. It is probable that the northwestern part of the State was swept over by migrating swarms during the summer, much the same as in the present year. But few traces of these were seen in the following year, except along the Upper Mississippi, where the damage was even greater than the year before. A general flight took place in July, and the direction of the departure was to the south and southwest generally, and was, perhaps, the occasion of the injury done in Iowa that year.

Again, in 1864, swarms appeared early in July, along the Upper Minnesota river, and spread eastward gradually during the season, and reached about as far east as in 1874, *i. e.*, to the third tier of towns in Le Sueur county. Scattering swarms also visited Manitoba in the same year, and probably some portions of these reached Northwestern Minnesota, for we hear of slight appearances of them in the Red River and the Sauk Valleys in 1864 and 1865. But the greater portion of the injury was done in the Minnesota Valley, and was followed by a general departure to the southwest in 1865. The injury in Colorado also was very severe in the same years, but there seems to have been no large movement to the eastward, such as occurred later, in 1866 and 1867.

It seems very likely that the swarms which entered Minnesota in 1864 were hatched at no great distance, and were the offspring of swarms that had alighted in eastern Dakota in the preceding

year. This may perhaps be inferred from the following letter of the Rev. S. R. Riggs, missionary at the Sisseton Indian Agency, dated Sept. 9, 1875:

"In 1863, it will be remembered, that on Gen. Sibley's expedition to the Missouri we met with the *ravages* of the grasshoppers in various parts of Dakota, particularly, as I remember, near Skunk Lake (in Minnehaha county) where the large grass had been eaten to the bare stalks, and our animals fared badly." He adds:

"In 1865, I visited a camp of Dakota scouts, near the 'Hole in the Mountain,' at the head of the Redwood. That was in the month of August. The valley of the Minnesota clear out to the Coteau was so full of grasshoppers as to make it unpleasant traveling. For the next four years, I traveled every summer on the Missouri River, coming over to and from Minnesota. Every season I met with grasshoppers at some point on the east side of the Missouri. In 1867, and also in 1868, we found them near Fort Randall. In 1869, in August, we met them above Fort Sully, near Grand River. In all these cases, they were only in small battalions, and appeared to have come there from other parts."

Again, in 1871, slight and scattering swarms of locusts appeared in Stearns, Todd, Douglas, Pope, Otter Tail, Becker and Polk counties, and perhaps in others. In all these counties they were in sufficient numbers to make themselves noticeable, and in some cases crops were injured, or a few eggs laid; but the occurrence would have been mostly forgotten by this time if it had not been brought to mind by more recent events.

The invasion of 1873 was something unusual in its character from the earliness of its arrival, the direction from which it came, and from the fact that it was the beginning of a visitation which has been prolonged to the present time by what, judging from former years, would appear to be unusual circumstances. Each summer since 1873, instead of being the scene of a general departure of the hatching swarms as in former years, has seen portions of these alighting but a few miles from where they were hatched, (generally in the next range of counties, and sometimes in other parts of the same county,) and depositing eggs for another brood. In addition to these, new swarms coming in from the northwest in 1874 and again in 1876, have added greatly in the area of devastation in both these years, and in the latter year to the area of egg-deposit.

## MINNESOTA AS A BREEDING GROUND OF THE LOCUST.

Without saying anything for the present about the new coming

swarms, the history of those that have bred inside the State since 1873 has been as follows: They reached the southwestern corner of the state about the first of June, 1873, brought by a wind that had been blowing freshly from the southwest for several days. During June and July, they spread themselves over the whole or portions of fourteen different counties, lying adjacent to each other, and throughout all this area locusts were found to be hatching in 1874. On acquiring wings, these flew northward early in July, and portions of them alighted in the range of counties next beyond those they had already occupied, leaving vacant the ground they had covered on hatching. By the 15th of July they had entered Blue Earth, Nicollet, McLeod and Renville counties. By the latter date, new swarms had begun to pour in from the northwest, and passed over the western counties to the southward. That these additional swarms did not add much to the stock of eggs deposited by our own brood is probable, for two or three reasons; first, because their progress, so far as it could be traced, was entirely across the state, and even across most of western Iowa, before laying eggs; and secondly, because the principal hatching-ground of 1875 was precisely in those counties which had been already occupied by our own stock in 1874 (before the arrival of new comers) with some slight additions to the eastward. Eggs were also laid, later in the season, in scattered spots in some of the northern counties, and in six towns in Meeker county, by swarms coming in from the northwest about the first of August. But the greater portion of the locusts hatched in 1875 were found along the Minnesota River, and these on flying moved southward, and alighted in the range of counties next beyond those they had just occupied, where they remained and deposited eggs during July and August. Of the swarms hatched from these last spring (1876) some flew away to the southward early in July, while others flew northward, some alighting along the Minnesota, and others moving still further north. Other swarms also came from the west, from the Red River valley, into several of the northern counties, and were probably a portion of those that hatched along the Red River. By the 10th of July all these had made their appearance in thirteen counties besides those in which they were hatched, but generally in small and scattered bodies, and in only two or three towns in a county; they were most numerous in Renville, Douglas, and Otter Tail counties.

The object of the preceding paragraph is to show that it is probable that the locusts which hatched in Minnesota last Spring were to a considerable extent the descendants of the swarms

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which entered the State in 1873. However unimportant it may seem, it has a certain value if it enables us to judge of the effect upon the Rocky Mountain locust resulting from a four years' continuous breeding in our climate.

### DEGENERATION.

So much has been said of late years of the tendency of the migratory locust to "degenerate" in the more easterly and southerly portion of the area visited by it, and this theory has been considered by our people so complete a failure, that it is worth while to state exactly what the theory is, and how truly it applies to our State. It might have been submitted at the start that opinions based upon a consideration of events still occurring, and more or less liable to be modified by new circumstances, should not be pressed too far nor too literally; and it was just that in judging as to the correctness of these opinions, that they should have been fairly stated. I give them in the briefest form in which I find them: "There is nothing more certain than that the insect is not autochthonous in West Missouri, Kansas, Nebraska, Iowa, or even Minnesota, and that when forced to migrate from its native home, from the causes already mentioned, it no longer thrives in this country." (Riley's Seventh Annual Report, p. 165.) It will be noticed that Dakota and Colorado are not included in this list; that Minnesota is to some extent excepted, and that, though not directly stated in the sentence quoted, the application is to swarms breeding one year after another in the regions mentioned, and not to such fierce hordes as have swept down upon us from the northwest in the summers of 1874 and 1876. The discouraging events of the last four years have served to confuse the question, and it is no wonder that our farmers, seeing the considerable numbers that have remained to breed here from one year to another, with the intolerable numbers that have been added in two out of four seasons, should come to believe that Providence has given over one half of our state to be henceforth the perpetual home of the locust. We have a series of occurrences so different from those of Missouri, Kansas and Nebraska, that it seems hard to account for them on any basis of mere accident or of which way the wind happens to blow when our swarms are ready to migrate.

The winds which sweep clean away the hatching swarms of the more southern states carry our own but a few miles from their birth place. It is evident that they are not detained here merely

by abundance of food, for the swarms of Kansas and Missouri leave behind them fields as rich as ours; nor by force of winds, for the same winds that bring down upon us invaders born hundreds of miles away, and carry them across our state and into more southerly regions, might also carry with them the broods of our own hatching. I believe it is not as yet fully known what connection there may be between the migrations of the locust and its season of egg-laying, but it seems that some cause for the fact that portions of our swarms remain here to breed can be found in an early stage of egg-laying. Here again we have a difference between our own broods, and not only the new swarms that come in upon us from the mountain regions, but also those which leave the more southerly regions and fly to the northwest on acquiring wings. As for the latter, in the flight from the Missouri Valley northward in 1875, Prof. Riley was able to learn of no case of their depositing eggs, nor were the hatching grounds, (outside of Minnesota,) of last spring found to be anywhere in the vicinity of those of 1875; as for the swarms that have descended upon us during the summer, I have not been able to learn of any deposit of eggs whatever in any of their stopping places on their way toward this state, and even on arriving here it was evident in most cases that they had not yet reached the season of egg-laying. Between the 17th and the 31st of July there was a gradual movement, apparently of new-comers, across the state towards Iowa, and the egg-laying did not become general until about the latter date. Between the first and sixth of August other swarms came in, and these again in most cases did not begin to lay until a week or more after their arrival. Still others came in later, and the laying was kept up until late in September and was seen to occur in October, or as long as the locust remained alive. On the other hand our own stock were seen in 1875 to be laying within eight days after their flight commenced and in the places where they first alighted, and during the past season the laying had already begun on the third of July and by the tenth had become general in the western part of Nicollet county, within a few miles from their hatching-ground, and within two weeks from the time when the flying began. This early period of laying may be of itself a sufficient cause for portions of our swarms remaining here, while the less mature pass on.

### NATURAL DECREASE FROM ONE YEAR TO ANOTHER.

But though portions remain, there is no increase in their num-

bers from one year to another. So far from holding its own, the locust has seen its breeding grounds decrease from nearly fourteen counties in 1873, to some seven and a half counties in 1874, and about five and a half counties in 1875; and in this latter area though able to inflict serious damage in many places (owing chiefly to the small acreage planted) they were in other places noticeably fewer than in former years.

This continuous decrease has resulted from several causes, and the first of these is the early stage of laying just alluded to, by means of which considerable numbers of locusts have hatched out during the last two autumns, and have died without reproducing themselves. In this connection, the state of Minnesota has an advantage over more southerly regions, in the fact that we are situated nearer to the breeding-grounds of invading swarms. Of these the earlier comers are more likely to pass over us before reaching the full period of their development, while the later comers are cut off by our earlier frosts; and of the eggs which are left with us, being deposited earlier in the season, more are likely to hatch in the fall and become harmless. On the other hand, the invaders are more likely to mass their forces in more southerly states, reach them in full maturity, and remain later in the season, while the eggs, being deposited later than ours, remain mostly unhatched until spring. These considerations enable us to understand why certain counties in Missouri, where the locusts hatched in 1875, presented in May such a picture of devastation and desolation as Minnesota has never seen in all its locust experience.

But while becoming prematurely developed, (if this is a correct expression of the facts as stated,) the locust had also become shorter lived. One year ago, there was hardly such a thing as a Rocky Mountain locust to be found in Minnesota by the first of September. The swarms that had hatched along the Minnesota River in the spring, and had alighted but a few miles further to the south in July, had almost totally perished in August, without extending the territory of their occupation more than the width of one county beyond the area which they covered on alighting. And in this connection we owe more to the Tachina maggot than many are willing to allow. But of the invading swarms of the present year, though large numbers of the bodies of the dead could be found in the fields early in September, (something unusual, from the fact that heretofore they have hardly ever been found at all,) large numbers remained alive until they were killed by frost, and even then died with eggs unlaid.

Still another effect of naturalization during the last four years

is an apparent change in character, slight in itself, but showing what the tendency would be if the locust were to continue to breed here. While it has lost some portion of its inclination or its ability to migrate, it has also lost somewhat of its gregarious character. This was shown by the young locusts last spring, moving over the fields in scattered bodies, or in no bodies at all, a peculiarity so noticeable as to attract the attention of the farmers ; by the movements of the swarms on leaving their hatching-grounds, in small squads and in various directions ; and by the fact that where they alighted first they left their eggs promiscuously here and there in the grain fields, instead of in bodies and in selected spots as heretofore. There was no general flying from their hatching-ground in large bodies, mostly in one direction, as was the case in 1874 and 1875. By the last week in June they began to leave some places so imperceptibly that their departure could hardly be seen, though their numbers were noticeably diminished. For the first ten days of July, small squads went careering up and down, south of the Minnesota river, and wherever there was anything like a movement of large bodies they seem to have left the state to the northwest, west, and southwest. In the meantime, others had spread themselves northward towards the North Pacific Railroad, and had alighted here and there in numbers sufficient to do considerable damage. But, judging from the occurrences up to the 10th of July, had it not been for new-comers, next year would have seen the insects so few and so scattered as to be incapable of great damage, and they might become, in a year or two, as flitting and as unnoticeable as the Red-Legged Locust that breeds with us every year.

Probably this is all that can be made of the "degeneration" of the locust so far as observed in Minnesota. It had not become so impaired in strength nor so diminished in numbers as not to prove a serious evil wherever it alighted or laid eggs. It was however decreasing in numbers, and gradually becoming less capable of reproducing itself. Something might perhaps be added in regard to changes in color and appearance; while the locusts which hatched in Minnesota last spring had when fully developed something of the darkness and dullness of old age, the brightness and fierceness of the fresh invaders was apparent to every one.

The facts stated show the general tendency, but there is a more vital question than the tendency of the locust to degenerate here. How long the state will continue to be one of the breeding-grounds of the locust, is simply how long new hordes will continue to sweep over us and leave here fresh seeds of future devastation.

Nothing is more certain than that we might, by general and continued effort, practically eradicate the offspring of almost any one year's invasion; nothing is more probable than that in almost any season, the whole body of our hatching swarms might be utterly swept away from our midst by favorable winds; and finally, if we may judge from the last four years, our breeding-swarms would decrease gradually from one year to another, and if not reinforced from abroad would finally become so few and so scattered as to be harmless.

### ANNUAL DEPARTURE OF THE LOCUSTS.

Besides the causes of decrease already mentioned, still another has been found in the impulse which moves the locust to leave its birthplace on acquiring wings. The considerable numbers that have remained behind each year, have created the impression that none were gone, and that the locust had become a permanent appendage of the state. But a collection of various items for the last three years, together with letters received from the eastern tier of counties in Dakota, shows that considerable numbers have left the state, generally to the northwest in 1874, and in various directions during the past summer. But, with Dogberry, we have been content to "take no note of him, but let him go, and thank God we were rid of a knave." It is only within the last year or two that it has become fully apparent that the final destination of these departing swarms is an important consideration, and one which serves to complicate the locust question more deeply than ever.

Whether or not it is a general rule that the locusts on acquiring wings seek the direction from which their parents had come in the preceding year, (a rule which the experience of Minnesota fails to substantiate,) it is at least certain that in 1875 "the main direction taken by the insects that rose from the lower Missouri valley country was northwesterly." (Riley's 8th Ann. Report, p. 105.) These swarms were traced by Prof. Riley, moving northerly from the end of May, through June and into July, and passing various points in Dakota, Wyoming and Montana.*

* He adds (page 108) "nor can I learn of any instance where these swarms that left our territory deposited eggs." The different case of our own breed of locusts, laying eggs within two weeks after the flying commences, is remarkable. But I am informed by Captain J. S. Poland, commanding at Standing Rock, that a swarm from the south alighted near that post, July 4th, 1875, and deposited considerable quantities of eggs between the 4th and the 18th of July.

They passed northward over Bismarck at various times between June 6th and July 15th. (Same report, p, 86.) But a still more definite statement as to the final destination of these northward moving swarms is found in an editorial of the Winnipeg *Standard*, of August 19, 1876, entitled "Locust Flights." It is there stated that in 1875,

> "The locusts which hatched in Missouri, Kansas and Nebraska, in an area of 250 miles from east to west, and 300 miles from north to south, took flight in June, and invariably went northwest, and fell in innumerable swarms upon the regions of British America, adjoining Forts Pelly, Carlton and Ellice, covering an area as large as that they vacated on the Missouri River. They were reinforced by the retiring column from Manitoba, and it seemed to be hoping against hope that the new swarms of 1876 would not again descend upon the settlements in the Red River valley. Intelligence was received here that the insects took flight from the vicinity of Fort Pelly on the 10th of July, and then followed a fortnight of intense suspense."

There is of course in all this a failure to connect by any direct chain of continued observations the swarms that left the Mississippi valley in 1875 and those which finally disappeared in the region of the mountains and in British America; still less is it shown that those swarms were the parents of those which are known to have hatched in the same regions in 1876, or even that those which are known to have hatched there were those which descended upon the lower country in July and August. But there is at least a strong series of probabilities.

A great deal has been said within the past two years about the practical help which the general government may perhaps find itself able to extend to the people of the Mississippi valley by attacking the locust in its native breeding-places, and it has been considered possible that some means might eventually be discovered of preventing or at least mitigating such inroads as that which has just ended. But if the events of 1875 and 1876 have any such connection as is claimed for them in the preceding paragraph, if the more northern and western breeding-grounds of the locust are recruited from the lower cultivated regions in alternate years, the problem of how to give practical help to the farmer will be greatly simplified. It would be hard to imagine a method of extirpating the swarms or the eggs of a hurrying insect from an extended area, or perhaps several such areas, of mountains and deserts, the resort of wild beasts and savages, where only armed bands can maintain a foothold; and on the other hand it would be hard for the government to find a time better fitted to begin the exter-

mination of the locust than when the mountain region must be measurably depleted of its stock, nor a place better situated for the warfare than a region where, with any fair assurance of conquering a peace, every inhabitant stands ready to do battle.

### STARTING POINTS OF INVADING SWARMS IN 1876.

Besides the region named in the article above quoted from the Winnipeg *Standard*, various parts of Montana are known to have been considerable hatching-grounds during the past spring. In the Bismarck *Tribune* of June 14th is found the following, which is quoted because it gives an idea not only of the place but of the nature of a breeding-ground:

"IN THE FIELD, NEAR ROSEBUD BUTTES, May 29, 1876.

"As we move westward the grazing improves, and here in the Little Missouri Valley the season is at least a month in advance of the season on the Missouri. This would be a splendid grazing region, were the water good. The grass is heavy and nutritious, but the water is strongly impregnated with alkali. Millions of locusts are just now making their appearance in this region. Too young to fly or do much harm, in a few days, should the winds favor them, they will sweep down upon the defenceless agriculturalists on the border, doing untold damage."

Officers who passed over the country between the Little Missouri and the Yellowstone rivers during the spring, state that at various points in that region young locusts were found in immense numbers. Shortly before the 23d of July, migrating swarms of locusts appeared in the vicinity of Gen. Crooks' camp; "myriads of grasshoppers filled the air, appearing like an immense drifting snow-storm, trending toward the southeast, and apparently taking advantage of a northwest wind to favor their flight to the same fields that they have effectually devastated for two consecutive seasons." (Extract from a letter of July 23d, quoted in the *Pioneer-Press and Tribune.*)

### MOVEMENTS OF SWARMS OUTSIDE OF MINNESOTA.

It is difficult to show any eastward movement across Dakota of these swarms that hatched in Montana. At Standing Rock, the movement was from the north. On the 19th of July, quite a large number were observed coming from the north, and by the 26th had about all disappeared from the vicinity of that station. Capt. Poland states that the main body appeared to pass to the west of

that station, moving south. No eggs were laid at Standing Rock, or in the immediate region. At Fort Sully, as shown by the records of the Signal Observer, the locusts appeared at various dates from the 14th to the 30th of July, and again from the 10th of August till September 2d ; but whenever the direction of their flight is given, it is to the northwest. No eggs were known to be deposited there. At Lower Brule Agency, on the 29th of July, an immense swarm alighted from a westerly direction, and flew again to the northwest, after remaining five days. At different times during the month of August, small swarms, coming from a westerly direction, alighted and died there. No eggs deposited. At Yankton, the course was generally south, through the flying-season.

It is probable that both in 1874 and 1876 the swarms that came into this state, at least in the earlier part of the season, were hatched in or near British America. This is to be inferred from the direction of their coming, the fact that we know of extensive hatching-grounds in British America in both these years, and that we know of no nearer hatching-ground. There is here also a failure to connect Minnesota with any known breeding-place by any continuous observations. But it is known at least that at Bismarck swarms passed south at various times during July, 1876. At Jamestown, (on the N. P. Ry., east of Bismarck,) a large swarm coming from the northwest on the 12th of July, dropped and remained until the 24th when they left, going south. On the 14th of August a very large swarm passed over southward without alighting. At Worthington, D. T., (still farther east, on the Northern Pacific Railroad,) the first flight appeared from the south on the 25th of June, stayed about 24 hours and on a change of wind went south. For the next six weeks locusts passed over that station in various directions.

At Fort Totten, "in the summer of 1875, grasshoppers hatched in the vicinity of the post, took wing in June, and left in the beginning of July. In 1876, there was no hatching, but they came and departed without doing material damage. They always go and come with the wind. They came about the middle of July, and left in about four days; came again two weeks afterwards and left without depositing any eggs. Swarms generally came from the northwest. They often pass over in large numbers without doing damage."

L. C. HUNT,
Lieut. Col. 20th Inf.

ENTRANCE OF INVADING SWARMS.

The rate at which swarms have been pouring into the state du-

ring the summer, may be judged from notes taken at points along the western line of the state of Minnesota, and from the eastern tier of counties in Dakota. I give them in regular succession, from Pembina southward:

Pembina, D. T., Aug. 31, 1876.—"No locusts hatched near here, and no eggs now deposited." —W. R. Goodfellow.

July 8.—"Grasshoppers first observed to-day. They could scarcely be seen with the naked eye, but by using colored eye-glasses they were made plainly visible. They were in great numbers, flying very high, far above cumulus clouds, and in a northeasterly direction."

July, 9.—"Grasshoppers flying northeast.

July 11.—"Grasshoppers, flying high, and moving southeast, were observed in great numbers."

July 12.—"Grasshoppers still appear moving south-southeast, flying very high; can scarcely be seen with the naked eye"

July 13.—"Grasshoppers still continue to be seen moving south by east."

July 17.—"Grasshoppers noted to-day, moving southeast, in greater numbers than heretofore, and flying considerably lower. None have as yet alighted."

July 20.—"Grasshoppers continue to fly over this place, moving from the northwest."—Records of the Signal Observer, J. Kabernagle.

Grand Forks, Grand Forks county, D. T. (nearly opposite Crookston) Aug. 28, 1876.—"A few locusts were hatched here and flew to the southeast early in July.

"A few lit on the 9th of July. They came from the north before alighting, but on the 8th the same grasshoppers flew north and returned next day, a few alighting, and all left on the 10th, without doing any injury—direction southeast.

"From the 10th, all through the month of July, when the weather was fine and clear, and the wind from the north or northwest, more or less of them flew over, moving in a southerly or southeasterly direction. But in no instance have I seen very heavy clouds of them until the 4th and 5th of August, when I was out on the head waters of the Turtle and Big Sault, from thirty-five to forty miles west and northwest of this place, I saw them moving in a southeasterly direction, in thicker and heavier clouds than I ever before saw grasshoppers flying. On the evening of the 5th it rained, and a considerable portion of them fell, and rose next day, moving in the same direction as before. And, strange to say, they rose without much sunshine, as the day was cloudy, and the sun showed itself only at intervals, and that for a few minutes at a time. I never saw them move before except upon a clear, sunshiny day, with a wind favorable to the direction in which they wanted to move. None lit near the Red River at this time.

"I do not think that any eggs have been laid here by those alighting in July, nor by those alighting on the 5th of August, west of here thirty-five or forty miles."—Hector Bruce.

Crookston, Polk Co., Minn., Sept. 2, 1876.—"On July 10th and 11th, swarms of 'hoppers came from the southwest, and lit at Crookston and vicinity, remaining two and a half days, and without doing any damage worth noticing; they were pairing. They got up on the third day, and went northeast. Three days later, a large swarm passed over us, going east of southeast, coming from the north. July 31st, a few lit here from the west, but doing no damage. August 10th, a few straggling ones came from the north, until August 15th, when they disappeared, going south."—Ross and Walsh.

Caledonia, Traill Co., D. T., (a few miles south of Crookston,) Aug. 30th, 1876.—"No locusts hatched here in the spring, nor were any eggs deposited They began to fly over about July 5th, generally going south or southwest, and for ten days there was hardly a day but what we could see some flying, most always going south."—Ara Sargeant.

Fargo, Cass county, D. T., Aug. 31, 1876.—"A few locusts were hatched here, and flew northeast on acquiring wings. A large swarm alighted on the 18th, and remained two days, without doing much damage. During the last half of July, and until August 5th, extensive swarms were passing over this county. Their destination was determined by the direction of the wind, either northwest or southeast.

"I cannot learn that any eggs have been laid here this season."—A. J. Harwood.

Breckenridge, Minn., Sept. 27, 1876.—"Grasshoppers hatched here from May 23d onward.

June 27.—"First seen flying to-day, few in numbers, going with the wind, from northwest to southeast, between 11 A. M. and 2 P. M.

July 4.—"Flying in great numbers this forenoon from 9 to 11:30, going from the north with the wind.

July 11.—"Hoppers coming down in swarms this forenoon, and flying from the north.

July 12.—"Hoppers left to-day, going south, as there was a strong wind blowing from the north all day.

July 19.—"Hoppers flying from the northwest to-day, in millions. Seen first about 9 A. M., and kept going until sundown; largest swarm seen yet, and looked like a great drift of snow.

July 22.—"A few hoppers seen to-day, flying between 10 A. M. and 3 P. M., from the north, slowly.

July 23.—"Hoppers flying from 9 A. M. to 5 P. M, from the north and northeast, but not in great numbers as on other days, none of them coming down.

July 24.—"Hoppers returning to-day, coming from the southeast, flying with the wind; began moving about 10 A. M. and till 4 P. M. None came down.

Aug. 1.—"Hoppers have appeared again in millions, coming from the north; are destroying the crop in Minnesota and Dakota. But few of them are rising to-day, as the weather is cloudy.

Aug. 3.—"Hoppers still remain, and are destroying everything, corn, vegetables and grass. A few seen flying during the entire day from the southeast.

Aug. 6.—"Hoppers began to leave about 10 A. M., going southwest; wind very light, and from the west. First seen depositing eggs to-day.

Aug. 7, 9, 10, and 12.—"Hoppers seen flying in small numbers from the southeast; still remain here, depositing eggs."—From the Records of the Signal Observer, W. L. Hearne, M. D.

Wahpeton, Richland Co., D. T., (opposite Breckenridge,) Aug. 30, 1876.—"A few locusts hatched here; so few that the dates of their hatching or departure was unnoticed. Eggs were laid only in scattering spots, after August 1st. They left before the egg-laying was finished."—Dr. Wilmot Smith.

Sisseton Agency, D. T., (opposite Big Stone Co., Minn.,) Aug. 12, 1876.—"In the upper portions of the Reservation, twenty-five miles north of the Agency, a small quantity of grasshoppers were hatched, in the latter part of May, and destroyed several grain fields and gardens. At different times in the month of July, we saw them flying over, sometimes in large numbers. Only a few straggling ones came down. The direction has generally been from a point south of southwest.

"On Sabbath, the 30th of July, we had a visitation all over the Reserve. They came down like snowflakes in winter, and covered the earth. Garden vegetables, especially beans and onions, were eaten up to the roots. Corn was pretty much destroyed, and potatoes and oats were very much damaged. The wheat was generally ripe, and but little eaten. They commenced leaving about twenty-four hours after they came, but it was the last of the week before we were free from them. They left on the same line on which they came, going towards the northeast or east of northeast. They were probably the same that have lately visited Herman and Morris, on the St Paul & Pacific Railroad. I understand they were quite as thick to the west of us, twenty miles, as here."—Rev. S. R. Riggs.

[These swarms appear to have reached Ortonville, Big Stone county, about the first, Herman on the third, and Morris on the fifth of August. They came eastward from the James river. The settlers along the James river state that no locusts were hatched there, and that all that appeared there during the season came from the northwest.]

Gary, Deuel Co., D. T., (Opposite Yellow Medicine Co., Minn.) Dec. 8th, 1876. "No locusts were hatched in this county last spring. The first flying swarm appeared in the latter part of June, flying northwest and did no alight. July 20 a very large swarm came from the southwest and went northeast; a few stopped and remained about 24 hours.

"August 15, they flew very thick, the largest swarm I ever saw. They came from the northwest and flew southeast. This swarm, as near as I can learn, was about 20 miles wide. [This probably furnished a portion of the swarms which reached Le Sueur, Mankato, and other points to the east and southeast on the 18th of August.] August 19th a swarm flew from north to south. August 24th a small swarm passed from northwest to southeast; and again in the same direction on the the 30th of August. On September 4th, 5th, 7th, and 9th small and scattering squads flew over to the southeast."—H. H. Herrick.

Medary, Brookings Co., D. T., (opposite Lincoln Co., Minn.,) August 30, 1876.—"The hoppers hatched last spring in this county and the northern half of Moody county. These became fully developed from the 25th of June to July 1st, and on the days between those dates they left in great clouds. The favorable winds for them seemed to be from north, northwest or northeast. They seemed inclined to go southwest.

"From July 1st until now the hoppers have been seen flying overhead nearly every day, moving with the wind, most numerous always with northerly wind. These alighted only once or twice in July, but only in small numbers, and remained only a short time.

"On Saturday, July 22d, very dense clouds passed over, (some so low as almost to darken the atmosphere,) with a northeast wind. They were going west. I have since learned that they rose from Minnesota, from the State line eastward.

"On Saturday, August 5th, very great swarms passed from west to east. At that time many alighted on the prairies, but not many in the settlement. The next morning, Sunday, I drove from Medary to Oakwood, about 18 miles north, and when about half way, I could see, for a distance of thirty miles up and down the valley of the river, dense clouds of hoppers rising. I have since learned that they extended more than 40 miles south of here, and I know more than 20 miles north, making a belt more than sixty miles wide.

"These I note as remarkable displays of hoppers. They could be seen every day, in what any reasonable man would call sufficient numbers. No eggs were laid in this county so far as heard from."—Rev. G. S. Codington.

Flandrau, Moody county, D. T. (opposite Pipestone county, Minn.) Sept. 12, 1876.—"A few hoppers hatched here, but did little damage, and flew to the south and southwest with the army which came over in July.

"The first flying over came about the 21st of July, from a northeast course, and that was the time they visited our crops and made a general raid. Since that time to the first of September, they have been flying more or less, but have done no great harm.

August 6.—"They passed over in large swarms to the southeast. These did us little harm. They have laid eggs to a limited extent in our county."—M. D. L. Pettigrew.

It will be seen from this that swarms from some source or other began to cross the state line to the eastward on July 8th, at Pembina, and that, as a general rule, the date of arrival of large swarms becomes later in the season the farther southward the point of arrival moves. And all these are only the incomings of swarms noticed at prominent points on the border; how many more have crossed or recrossed at other places where there was no one to report their comings, can only be guessed at from the immense clouds that have rolled over the state, passing and repassing each other to the south and east, from the 20th of July to the first week of September. At least one large swarm, in addition to those already recorded, must have entered somewhere to the northwest of Douglas county, shortly before the 18th of August. But whatever form or continuity these bodies may have had before reaching the state, it was soon lost after their arrival. It is not easy to trace them, even from one county to another, as they passed over ground already occupied by earlier comers. All we can say is, that there were extensive movements in certain directions, on certain days.

### MOVEMENT OF SWARMS WITHIN THE STATE.

The movement of the various swarms of our own hatching early in the season has been already given. By the 10th of July the counties to the south of the Minnesota river were generally free from locusts, and had begun to congratulate themselves on their delivery. Between the 10th and the 20th the locusts had begun to increase largely in numbers in the northern counties, but the fact that additions had already begun from abroad was not generally known. The greater portion of these had begun to move southward by the latter date and passed various points between Lac qui Parle and Madelia on or soon after July 20th. They passed gradually along over the counties that had been injured during the spring by our own stock, and by the first of August had reached the southern line of the state and many had passed on into Iowa. As they moved along, portions remained behind here and there, but there was no extensive deposit of eggs until they reached the southern half of the lower range of counties in the state. It seems probable that these bodies also brought with them to the southward, parts of our own hatching swarms that had flown northward early in the month. But by the twentieth of the month the locusts had mostly disappeared from along the lines of the Saint Paul and Pacific, and

the Saint Paul and Sioux City Railroads, and there were congratulations once more that "the hoppers were gone." A line showing the eastern limit of their raids at this date would pass, generally speaking, along the eastern boundary of Todd county, through Stearns, Meeker, the eastern part of McLeod, through Sibley, Nicollet, and the northwest corner of Blue Earth, and in Martin county as far east as Fairmont.

Between the end of July and the sixth of August, new swarms had been collecting in Otter Tail, Grant, Stevens, and Big Stone counties, and in some of the eastern counties of Dakota; and on the latter date, a wind from the northwest gave these an opportunity they had apparently been waiting for, and there was a general flying to the east and southeast, over a large portion of the western half of the state. In the southwestern counties, where the new-comers could be traced directly back to Dakota, there was very little alighting, and they mostly passed over into northwestern Iowa. By this raid of the sixth of August, the area of visitation was extended eastward to St. Cloud, into Wright and Le Sueur counties, and across Blue Earth and Martin counties. After the sixth of August, clear weather and favorable winds, at various dates, carried the line still further eastward, as on the eleventh, the fourteenth, and especially on the eighteenth of August, when large swarms flew over Elk River, Monticello, Glencoe, Shakopee, Blakeley, Belle Plaine, Le Sueur, Mankato, and Blue Earth City, and one flight was seen as far east as Hastings. During the week ending August 26th, they were seen flying over or alighting at various times in Rice, Waseca, Steele, Faribault and Freeborn counties, and are said to have appeared over Rochester. By the first of September they had added Waseca, Freeborn, Carver, and portions of Hennepin, Sherburne, and Benton counties to the "grasshopper regions," and some slight additions to the eastward have been made since the latter date.

The comparatively slow rate of progress to the eastward through the season is surprising, considering the long distances which the locust is supposed to travel, and the impression which one receives from seeing a swarm passing in one direction through an entire day. It is easy to imagine that such flights must have come immediately from British America or Montana, and that they will shortly reach Wisconsin and Illinois. But the locust, as it appears in our state, moves (with perhaps rare exceptions,) by day only and often for only a few hours in the day, and a halt for the night is easily prolonged by head winds or cloudy weather into a halt for several days; nor do the swarms move continually

eastward, although the line of encroachment is continually moving in that direction. In one case at least, a body that had moved easterly over a county on the 24th of August, returned directly west one week later. (Freeborn County *Standard*, editorial, Aug. 31, 1876.) There is no knowledge that any swarm has (in Minnesota) reached the Mississippi river south of Hastings.

But the general direction of movement since the twentieth of July has been to the southward and eastward. The experience of the summer has shown that the Big Woods offer no impassible barrier. Hitherto, the incoming swarms have reached about as far east (but not in great numbers) as Lake Washington, in Le Sueur county, longitude 16° 50' (nearly) west. They have reached this point toward the end of August, when impaired in strength and activity. But the invasion of the past summer has been characterized by the incoming of fresh and still active swarms late in August, and these have been carried by winds blowing freshly from the west, as far east as Mower county, longitude 16° west. It may be proved in future that the eastern limit of invasion is determined solely by the extent to which winds prevail from the west, together with the length of the season during which the locust retains its full activity and strength. The connection between the movements of the locust and the prevailing direction of the winds, seems likely to receive more attention than has hitherto been paid to it. While the timbered country of the northeastern part of the State has been but little infested, to any great distance east of the Mississippi, it may be said that that portion of the state does not lie in the direct line of invasions. There is nothing to show that swarms purposely turn aside from the heavily timbered regions and go elsewhere, although in partially timbered sections they alight mostly in the open farms. But, having once entered the timber, their progress is soon ended, and no more fortunate destination could be selected for our departing swarms than Northeastern Minnesota. Locusts have been quite numerous about Brainerd throughout the summer, since early in July, and their numbers were perceptibly increased on the sixth of August, apparently brought in by a strong wind from the southwest; but these evidently found their progress impeded by the timber, for they did not extend to any distance east of Brainerd, along the Northern Pacific Railroad, nor did they lay eggs extensively about Brainerd.

The connection between flying movements and the direction of the winds may be shown by the following diary kept by Lieut. R. B. Plotts, of Elk township, Nobles county:

July 5.—"Light wind; first flight came from the northeast, and commenced to settle down about 10 A. M.; attacked gardens first of all. They remained here till Sunday, the 9th, when in a brisk breeze from north-northwest, a light rain the night before, they flew from early in the morning till after sundown, and lit heavily south of me.

July 10.—"Wind southeast; flew heavily to the west, the highest appearing to sheer off southwest. Got a heavy light from those east of me.

July 13.—"Late in the afternoon wind suddenly veered to northeast, and they started immediately. Nearly all left me.

July 15.—"Wind north, veering to the east. Not a very heavy flight to the west.

July 16.—"Wind south-southeast. Still going west.

July 17.—"Wind east, trending north, showery. Before the showers commenced, could be seen going west. That ended the first raid. No more flying over till

July 20.—"Second raid came in on a west-northwest wind, and lit at night.

July 22.—"Wind north-northeast, heavy flight, and coming down all day.

July 23.—"Wind northeast, haling east. Heavy flight; came down heavily, and covered everything nearly.

July 24.—"Wind varying from north-northeast to east. Coming and going all day; some commenced laying eggs, which was kept up till this raid all left us.

July 27.—"Wind from north and east. Heavy flight, and most of them left here.

July 29.—"An east wind took all this raid away, the upper current being to the southwest. No more flights until

Aug. 6.—"Light wind from northwest. Another heavy raid came in. These remained till

Aug. 10.—"When wind again came from the northwest, and it rained. As soon as the shower was over and before the sun shone out, the hoppers started in heavy flight.

Aug. 12.—"The red mites were first noticed doing much damage to the eggs.

Aug. 13.—"Another showery day, and immediately after the rain they started south.

Aug. 14.—"Wind from north and north-northeast. They started early and before the sun came out, although it was quite cool; about all of this raid left.

Aug 16.—"Very cloudy, with variable winds. Suddenly, while it was quite dark with clouds, the hoppers jumped up and flew off southwest; the very first puff of wind from the northeast, and they all left here.

Aug. 18.—"Wind again from the north. A very heavy flight passed over, high up in the air. None alighted. Red mites disappearing.

Aug. 23.—"Wind hauling to westward, and some few stragglers flew as near south as they could.

Aug. 24.—"Wind northwest. Grasshoppers very high and heavy flight to the southwest.

Aug. 25.—"Wind northwest Heavy flight to the southwest, very high.

Aug. 31.—"Showery for several days before; wind suddenly north-northwest, and by 10 A. M. many grasshoppers were flying. By noon, in the upper air and almost indistinguishable, was a heavy body going southwest. None lit here.

"On the dates intermediate between those given the wind was very light, and there were no flights, except perhaps short ones, from one part of a field to another.

"When the directions of flight are not expressly stated, they correspond almost exactly with the direction of the wind."

## AREA OF THE PRESENT DEPOSIT OF EGGS.

A line showing the eastern limit of the area where eggs are now deposited in Minnesota would include (very nearly) the western tier of towns in Mower county, the western part of Steele, Rice, and Scott counties, the whole of Carver, the western part of Hennepin, along the river, (and in many places thickly in the timber farms,) in Sherburne and Benton counties, the southern part of Todd county, then westerly including Otter Tail, the southwestern part of Becker, and portions of Clay counties. To the south and west of this line the locusts have had possession of more or less of the state from the fourth of July to the first of October, and it would be difficult to specify with any exactness especially in the eastern part of this area, where eggs are most or least thickly laid. But the counties along the Red river from Glyndon to Lac qui Parle are comparatively free from eggs, unless in the eastern portions, and again many towns from Madelia westward in Watonwan, Cottonwood, Murray, Redwood, and the whole of Lyon and Lincoln counties are almost entirely free from eggs.

The accompanying map will show the areas of egg-deposit for the last four summers, but the lines must not be construed too exactly. They are intended to cover generally the outside limits. As for the limit of the deposit during the present year, it is impossible to draw it exactly, and no doubt a few locusts will be found hatching in many spots next spring which lie to the east of this line. Late in the season, considerable numbers passed over Owatonna to the eastward, some over Mantorville, and possibly a few over Rochester, and these, perhaps, will be found to have alighted and laid eggs somewhere in the southeastern counties. On our borders eggs are laid in the southwestern counties of

Dakota as far north as Rock Co., Minnesota, and in Iowa as far east as Mower county.

### PLACES WHERE EGGS ARE DEPOSITED.

These eggs have been deposited, as a general rule, in the vicinity of cultivated fields, and in each township the extent of the deposit is measured, in some degree, by the amount of land under cultivation. It is not presumable, at least, that wild prairies or lands lying far distant from tilled fields, are extensively filled with eggs. The locust is attracted and held by the growing crops, and it seems to be something more than a mere coincidence that the area devastated by the young in the spring does not become a laying-ground in the summer; this is especially true of the present year, and the same strip of country where the locusts hatched in the spring, and where the little that was planted, was mostly consumed by them, is at present exactly that portion of the infested area that is now most nearly free of eggs, although the deposit is abundant enough in the counties to the north and south of it. Nor do the prairies, when covered with grass, present many favorable situations for the deposit of eggs. The experience of the summer would seem to show that almost any bare, sunny spot, where the earth is hard enough or moist enough to retain the shape of a hole, is selected by the locust when she is ready to lay. To what extent the prairies in general are filled with eggs, cannot be told, of course, until the time of hatching arrives, but in the vicinity of cultivated fields the wild prairie has received its share of eggs. Throughout the whole area already given, with the exceptions named, there is hardly a town where the deposit was not so extensive by the first of October as to form one of the most serious of all considerations for next year's crop. These eggs are laid sometimes in ground so hard as to resist the point of a knife-blade, sometimes in sand-heaps so soft that the next shower washes off the sand and leaves the egg-cones standing like pegs in the ground; on knolls high and clear of all moisture, on sand-bars in the rivers, and in flats so low as to be overflowed by the next rain. But the most favorable spot of all, everywhere, is new breaking. Grain fields have generally suffered most damage on the sides nearest to new breaking, and, conversely, in new breaking more eggs are laid on the sides nearest to grain fields. In some counties, a large amount of new breaking has been done by non-residents, and will furnish a fruitful source of evil next spring. Of circulars sent to nearly all the infested towns to ascertain the extent to which eggs

were deposited during the season, the following, from Blue Earth county, is a sample of all, as to the extent of the deposits, and the spots where they are situated:

**Beauford.**—"All over the town; not much in the stubble, but on all bare spots, such as sheep-pastures, between the rows of corn and potatoes, gardens, all places that were clean of weeds, river bottoms, where fed close, timothy stubble and road sides."—J. S. Larkin.

**Butternut Valley.**—"It would be difficult to run down a spade and turn the dirt anywhere in stubble, corn, potato fields, meadow, or road, without finding eggs. It seems as twenty to one before, and they destroyed everything."—Samuel D. Shaw.

**Ceresco.**—"Over the whole township, very thick in most places."—J. M. Mead.

**Jamestown.**—"They have deposited their eggs on nearly every farm in this township."—A. P. Davis.

**Judson.**—"They have laid eggs very extensively, especially on new breaking and roads, some in the stubble, grass, prairie and corn lands."—Humphrey H. Jones.

**Leray.**—"Eggs are laid on every clear, dry place in the town; mostly in corn fields, potato fields, gardens, and in the highway."—Ira B. Reynolds.

**Lime.**—"In the flats along the Minnesota river they are thicker than in the timber, but along the roads, and in old pastures, they are so thick that nobody can have an idea, unless he has seen it himself."—Jacob Born.

**Mapleton.**—"There is not a farmer but claims that every favorable spot on his farm is thoroughly peppered."—J. E. Brown.

**Medo**—"All timothy pastures, all new breaking, in the roads, and in some stubble to a limited extent—from 6 to 10 acres in each quarter."—B. F. Steadman.

**Rapidan.**—"Every favorable place is well filled; roadsides, tame pastures, and new breaking thickest, corn fields next, and stubble fields and unbroken prairie least."—James B. Swan.

**Shelby.**—"All along the highways and especially on all new breaking and old pastures, corn fields and prairie lands that are eaten out by pasturage, and in fact there is no such thing as exception from them."—Thomas J. Cross.

South Bend.—"Eggs are deposited in every rood of dry ground in the township."—D. P. Davis.

Sterling.—"In some places the eggs are stuck in very thick, but in the fields generally the eggs cannot be very thick. Still, in the aggregate there are very many, being everywhere, even in the timber."—N. A. Hunt.

Vernon Center.—"Eggs are deposited all over the township, and in some places very thick, seemingly no room for more, and in other places (wheat stubble,) not so many."—E. W. Washburn.

The laying this year seems to surpass that of former years not only in the area filled, but in the numbers deposited everywhere. This could hardly fail to be the case when the laying commenced early in July and was prolonged into September, and when some towns received deposits from two, three, or even four different bodies. Where new breaking was harrowed in the fall the eggs often appeared strewn on the surface as thickly as grain is sown; e. g., "I have just dragged a new piece of breaking, and the eggs were as thick as wheat sown at the rate of one and a half bushels per acre; but I think they are thicker on breaking than anywhere else. (S. S. Clevenger, town clerk of Bismarck, Sibley Co.)

### TIME OF DEPOSITING EGGS.

The time when eggs have been deposited this year has been stated already. The time when, or rather the age at which the Rocky Mountain Locust deposits its eggs, is a different question. The same species has laid eggs in Kansas, this year, as late as the 13th of November, and may continue to lay in Texas as late as the first of December. (Riley's 7th Ann. Report, p. 192.) If the mission of the locust is to lay eggs once and die, what could be the time or place of birth of those insects which have apparently just reached maturity by the first of December? Although it has been considered possible that these are a second brood whose parents were hatched in the preceding April or May in Texas or Colorado, there is no knowledge of the time or place of any such second hatching. If these late laying swarms are such as those which come down from the Snowy Range in Colorado, in the latter part of August (vide N. C. Meeker, quoted in Riley's 8th Ann. Report, p. 84) it must be admitted that the mountain-born broods are a longer-lived and more vigorous race than any bred in Minnesota. Besides this, among the swarms which have come in upon us this year, many were found dying as late as October, containing eggs.

That the Rocky Mountain Locust lays eggs twice or three times in a lifetime, has been the result of some guess-work among our farmers, who considered it necessary in order to account for facts as they saw them. I give the result of a single experiment.

On the 25th of June, I shut up in wire gauze cages nine pupæ of the Rocky Mountain Locust. The bottoms of the cages were filled with earth packed hard, and the insects appeared to thrive in confinement. By the second of July they had all become perfect insects. By the 8th of July they commenced coupling, and were seen repeating the act for several days. On the 15th and 16th two of the females went through the form of depositing eggs, and I marked the place of deposit on the edge of the cage. The coupling was repeated again as before, until the third of August. At that date the coupling ended, and the locusts became almost inactive, and were seen to eat very rarely afterward.*

On the 14th of August one of the males died; the female died on the 9th of September, and was found to contain fourteen full sized eggs, but I found on examining the cage that there was also a full sized egg-cone where she had already appeared to deposit on the fifteenth of July. Of the rest of the Rocky Mountain Locusts the males were caged with some female Red-Legged Locusts caught in my garden, and although the two species did not seem inclined to have much commerce with each other, I saw one pair coupling. These observations are very slight and imperfect, but are given for whatever they may be worth. That the male dies first may be inferred not only by the above experiment, but from the fact that in September it was common to find many pairs coupled, of which the female was alive, but the male had died without releasing himself.

## PARASITES AND ENEMIES.

The various insect enemies of the Rocky Mountain Locust have been described sufficiently for common information by Prof. Riley on pp. 44-46 of the "Report of the Proceedings of a

* The early part of this coupling season was one of the greatest activity on the part of these insects; they dashed themselves against the wire of their cages as though all space would be too small to contain them; there would be a flash of the wings, extended and closed again in an instant, or that movement of the hind legs known as "fiddling," which seemed to be a well known signal between the male and female. In cages, where several pairs were confined together, the male, while in the act of coupling, would repeat this movement, if brushed against by another.

Conference of the Governors of several Western States and Territories, at Omaha, Nebraska, in October, to consider the Locust Problem." As the descriptions are further illustrated by figures, and as the pamphlet is intended for public distribution it may serve to prevent some of the confused knowledge about these parasites and enemies which has heretofore prevailed to a considerable extent. The amount of help which may be expected, or has already been received, from these enemies of the locust is, in *limited areas,* even greater than Prof. Riley would assign to them. There are farms where in loose, mellow soil it is now almost impossible to find eggs, yet but a short distance away eggs may be found in abundance in hard ground. There was also great difference in the different flying swarms in regard to the presence of the internal grub. While in some places hardly a locust (one out of five,) could be found that was not affected by some internal parasite, in others they were almost entirely free from them. Mr. W. C. Ralls, of Le Sueur, examined 624 locusts between the 7th and 10th of September, and in 9 of these the grub was found, and in 10 the hair-worm. It would be well if we could add to this help which is given without expectation of bounty or relief, the help which might have been added by thousands of prairie-chickens killed during the fall. When a whole community stands in need of every form of assistance that man and nature can render, it is worse than useless to throw away the help, however slight, that any willing instrument is ready to contribute.

## DAMAGE TO CROPS.

The form and substance which this report might have been expected to assume early in the season, have changed considerably under changing circumstances. The various means of contending with the locust have been set forth generally and in detail during the past four months; and the amount of damage which has been inflicted upon the crops, while it might have been ascertained with some precision in five or six counties, has become a different matter when combined with severe losses by drouth, and extending over thirty-five or more counties. The exact amount of loss in so many different counties, varying as it does from almost total loss of the grain crops to slight injury to gardens and late corn, can not be arrived at with any less efficient machinery than that of the Commissioner of Statistics, to whom the whole of this portion of the subject properly belongs.

Of grain, the oats and barley have, as usual, suffered the most; in Raymond, Stearns county, where the locusts were most numerous from the 23d of July to the 20th of August, "the Lost Nation wheat was only slightly damaged, while the Fife wheat was ruined." (So stated by L. B. Raymond, Esq.) The same fact was noted by P. Hoffman, Esq., of Westport, Pope county; but it is not known how generally the rule will apply.

Corn and potatoes have escaped with less damage everywhere, though corn attacked in the silk has been ruined. Peas are never specially mentioned except to note their escape from injury. ("On the whole, we consider peas and potatoes the best crop to raise."— S. S. Gillam, Big Bend, Cottonwood county.) Sorghum is almost locust proof so far, both against the young and old. Flax, tobacco and beans are generally mentioned to note their almost total destruction. Farms lying on the east side of lakes have often suffered less than others, both in this state and Dakota. In some cases farms situated in the timber have been passed over altogether; in others they have yielded 5 to 10 bushels to the acre, while crops on the prairies in the same town have been failures; on the other hand, rarely the timbered portions of a town have suffered more severely than the prairie farms.

## PRACTICAL METHODS OF CONTENDING WITH THE YOUNG LOCUST.

The different means of contending with the locust both in the egg and the unfledged state, have been set forth so fully and so often within the last two years, that they ought by this time to have reached, in some form or other, the hands of every reading man in Minnesota. The report of the commission appointed by Governor C. K. Davis in 1875, (of which some 5,000 copies were printed,) the proclamation of Governor J. S. Pillsbury, issued August 30th, 1876, containing the gist of all the known methods of locust warfare, and the many and oftentimes excellent amplifications and details of these methods, as they have appeared in the state newspapers during the summer, cover the whole ground so far as it is known. Finally the Report of the Proceedings of the Omaha Convention repeat, in twelve excellent pages, the whole subject once more, and a reprint of these in the newspapers of those counties where the evil is new and comparatively unknown, ought to leave no further lack of information.

It ought also to be understood that these sources contain all that has so far been made public on the subject, and that the farmer must for the present defend his crops by these means or

not at all. We are so accustomed to the comprehensive methods of farming by machinery that it is hard for us to come down to the petty exercise of individual exertion which the European peasant would consider only a regular portion of his daily existence. But whatever may be the success of various machines and applications which are now in preparation, but not to be disclosed at present, there is as yet no labor-saving contrivance, capable of being applied over large areas, which can accomplish anything like a universal destruction of the young locust, and the general law of labor holds good, that a man's success is measured by the earnestness of his own endeavor. Even the difficulty which results from sparseness of population may be overcome in some little measure; where a few farmers in a township where eggs are laid have determined to sow a small acreage and to defend it to the best of their abilities, something may be gained by combining and sowing in partnership, or side by side, the fields that would otherwise be distributed over a township. Of course there are objections and difficulties to any such method of proceeding, but they are at least no greater than those already presented in the mere fact that the locust is present. On the other hand the advantages would be great; half a dozen families acting in concert and in the defense of one large field would accomplish far more than by any disjointed efforts; it would be far easier to defend the four sides of one large field than the twenty-four sides of half a dozen smaller ones; and lastly the single field would have a smaller number of locusts in the aggregate to contend against, and insects hatched at a distance from it might never reach it before flying; at least it is certain that fields lying within three miles of the hatching grounds of last spring, remained untouched until the flying season.

## WHAT MAY BE DONE BY ENERGY AND PERSEVERANCE.

Although it is impossible for me to add at present anything to the many and various methods of locust-warfare that have been repeated so often, it may be of some value to show what has been or may be done with those already known. It was not as a mere form of speech that the conference at Omaha concluded with these words:

"That our consultation with each other and with those who have tested the matter, has resulted in the firm conviction that by proper efforts, concerted action, and a vigorous and determined warfare against them, the young grasshoppers which may be

hatched out next year, or any subsequent year, can be successfully fought and our crops saved; that we are not without remedy, but we may protect our crops against them if we will but make use of the means within our reach."

The conditions of success here noted, "proper efforts, concerted action, and vigorous and determined warfare," have never yet been applied in Minnesota. The truth of the above quotation, is shown by the fact that where even individuals, contending not only against the locusts hatched about them, but against those which the concerted action of their neighbors should have rendered harmless, have defended their crops with perseverance and determination through a whole season, they have in the end received a return which justified both their usual and their extra labor. Even the most petty means of defence, if kept up persistently through a whole spring, will often effect a saving of a considerable portion of the crop. The town of Lime, in Blue Earth county, one-half of a government town, in 1875 turned out its whole population to battle with the young locusts with brooms, switches, and every weapon they could lay hands on, and returned an average crop of 12 2-3 bushels of wheat, 36 bushels of oats, and 36 bushels of corn to the acre. The town reported no damage from locusts, and the return was about the average crop for the whole county, and a fair yield.

Charles Pelzel, of Milford, Brown county, by spreading tar over strips of building paper, and placing these along the sides of his fields, saved most of his crop, while those of his neighbors were badly damaged. The paper was re-spread with tar as often as it became covered with young locusts. On 25 acres of wheat he saved 223 bushels, and on eight acres of oats 400 bushels. All this was at a cost of $3 for tar.

Mr. N. V. McDowell, of Bigelow, Nobles county, who has fought the locusts persistently ever since they came in 1873, by 10 days' extra labor in hauling and burning straw, saved a fair crop on 55 out of 70 acres cultivated, but his exertions were rendered useless by the raids of July and August. Even after these he was able to harvest five bushels of wheat to the acre on early sowing.

The only crop of small grain harvested in the town of Holly, Murray county, this year, was by Mr. J. M. King. He writes:

"I put in about 50 days' labor for one man. I caught 100 bushels in my net, and destroyed as many more by scattering straw over their hatching grounds and burning them. I also put to flight swarms and droves of them after they began to fly by use of bags nailed on to from 25 to 50 feet of pole or board, with which I trailed back and forth across my fields, at times

driving them like sheep, and at other times not making much impression. I saved 450 bushels of wheat from 52 acres, but firmly believe that if we had had a favorable season, the hoppers would have hurt it but little; but the dry weather, coming as it did, seemed to kill it."

The following experience is also worthy of being recorded:

"Mr. S. W. Danforth, of Madelia, Watonwan county, after having once resolved (in 1874) that he would put in no crop whatever should the locusts deposit eggs on his farm a second time, resolved once more in 1876 that he would determine whether he or the locusts should be master of his farm. On the north side of his wheat field was a prairie ridge where the locusts hatched in the spring. These, while very young, began to come into the field on the north, and had reached it before being discovered. He began by burning them with straw on the edge of the field and on the adjoining prairie, constructing a ditch along the side of the field at the same time. Smaller ditches were also made inside the field to stop those which had already entered. When young, they were also delayed by simply harrowing over the soil and presenting a rough surface for them to crawl over. Seven or eight days were spent in this way, and after the ditch was finished, it turned away the locusts so completely that the work was considered done, and the crop saved. On the western edge of his field was a strip of prairie grass, 40 rods wide, and beyond this some stubble and old corn grounds, belonging to a neighbor. Here the locusts hatched out abundantly. About a week after work was done on the north side of the field, these had crossed the strip of prairie and entered the field from the west before being noticed. As soon as they were discovered, he got all the help he could and made a ditch as fast as possible. This stopped them for nearly a week, and then they began to cross it. He hitched a horse to a plank and walked him up and down in the ditch, and this turned them aside for a while. There was a cloudy day on which the locusts rested, but when the sun came out they were ravenous, and there was no stopping them. They crossed the ditch, and filled the straw-fire so full as to extinguish it. He called in his neighbors to see what would happen to them if the locusts were allowed to keep on in their course, and five or six turned out with teams, hauling straw. With this they burned over a strip three or four rods wide and a hundred rods long, along the edge of the field. But in spite of all his efforts, the locusts had made their way into his wheat, and by this time he had finished a catching-net. The next day, in five hours, he caught from 15 to 20 bushels. This was continued daily, until 75 or 80 bushels had been caught, and it was not necessary to use it, except as occasion demanded on certain days, or in certain spots where the locusts were thickest. This work was so effectual that there should have been (except for drouth) a fair crop of wheat, or at least half a crop all over the farm, except where the burning was done. This demonstrates the possibility of one farmer's fighting two farmers' locusts, and still saving half a crop."

## CATCHING-MACHINES.

Many other isolated cases of persistent and partially successful efforts in saving crops from the young locusts have occurred this year; I mention these because they have been reported more fully than others. It also shows what can be done with machines in the later part of the season, and what might have been done by attacking the locusts in their hatching-grounds instead of waiting for them to approach the grain. The coming spring seems likely to test what can be done with catching-machines. Not only are several elaborate ones patented or prepared for use when the time comes, but many farmers are already preparing such machines after their own fashions. To those who are deterred by cost or by lack of a model, it should be said that an efficient machine can be made at a cost of a few poles or strips of board, a pair of wheels, a few yards of stout canvas, and just sufficient ingenuity to construct a long, open-mouthed bag to run over the fields with its lower edge near the ground, and running back in the rear to a sack to contain the locusts that are caught. Mr. King's net was such, and captured from two to eighteen bushels per day, depending on the size and age of the locusts.

Mr. Danforth's machine consisted of two wheels, connected by an axle 20 feet long and six inches in diameter; this was made of a stout pole obtained from the woods, and it was necessary that it should be so large and strong, for the loads of young locusts captured were sometimes so heavy as to bend even this badly. Across the top of this axle two poles, of about the same diameter as the axle, were fastened, running back nearly to a V some eight or ten feet behind the middle of the axle, and extending forward and opening out in front of it. The front ends of this V was steadied by a cross-piece. This was the frame-work. The net was made of about 40 yards of cotton cloth, cone-shaped, in front about 18 feet wide, from one side to another along the axle, and six or eight feet high from the ground to the top of the net. This net narrowed back about seven feet until it was some five or six feet in diameter, and terminated in a stout canvas bag three or four feet long, closed with a string at the rear end. The heavy loads of locusts caught (sometimes 500 pounds) made it necessary to have a support for the net and bag, and for this purpose a triangular floor-work of boards was made, the front end supported from the axle, and the hind end from the hind end of the V poles, and running as near the ground as possible. The lower edge of the net in front was kept close to the ground by a piece of light scantling fastened

to the edge of the cloth, and rising and falling over uneven surfaces. The horses were hitched to the ends of the axles, outside of the wheels, their breasts extending forward nearly to the front ends of the V poles, where they were fastened by the head. The net sloped backward at the top in front, and when the machine was in motion a man stationed on the axle with a broom gave the locusts as they entered the net a start toward the rear end. Just where the cone terminated in the oblong bag, a large piece of canvas had been cut out and wire gauze inserted, and the locusts moved towards this on getting into the net, attracted by the light. The only outlay in constructing this machine was for the 40 yards of cotton cloth. This net captured from eight to twelve bushels of pupæ per day when first used, and the amount diminished daily till the 24th of June, when about two bushels were taken.

Mr. Andrew Webster, of Norseland, Nicollet county, had, in 1875, about 230 acres of wheat sown. The locusts began to hatch about May 17th, and he commenced at once to destroy them by burning with straw. As it was impossible to protect the whole of his crop with the help at hand, he selected a field of fifty acres to defend, and burned all the locusts that hatched near it. This continued until June 11th, when the straw was exhausted, and the locusts had begun to come in from the adjoining fields. Two catching-nets were then rigged up, (of the usual form,) attached to axles fourteen and sixteen feet long, each drawn by one horse moving at a fast trot. The amounts caught were: From June 11th to 17th, (part of the time with one net,) 121 bushels; with both nets, June 17th, 37 bushels; June 19th, 20 bushels; June 21st, 77 bushels; June 22d, 63 bushels; June 23d, 45 bushels; June 24th, 71 bushels; June 26th to 28th, 128 bushels; June 29th, 59 bushels; June 30th, 28 bushels; July 1st, 18 bushels, when the work was discontinued, as the locusts had begun to fly, and had become too scattered to be caught easily. The catching was done along the edge of the field, and between the hours of five and ten P. M. It required the labor of four men and four horses during these hours. The whole number of bushels caught was 667, and, on threshing, 658 bushels of wheat were harvested from the fifty acres.

## DITCHING.

The experience of Minnesota in regard to ditching, in 1875, was so successful, and so strongly and fully confirmed by the testimony of reliable men, that the experiment should have seemed worthy

of a more extended trial than it has received this year. But few ditches have been dug, but these, even when left to take care of themselves, have generally served as a barrier during the earlier half of the season. A ditch, to be effectual, needs care and watching; when its sides have been washed down by repeated rains, and it becomes a mere curved surface, it is a very slight barrier indeed. The time and trouble of constructing such ditches as these, would be spent better otherwise.

### CONTENDING WITH WINGED LOCUSTS.

Here and there during the past season have been cases of one farmer or a few farmers in a township who were able to save some portion of their crops from the flying swarms. The number of cases where this has happened is in some twenty-five or thirty out of the whole number of towns in the state that have been invaded. When there has been any success at all it has generally been early in the season, and over small patches of garden or cornfields. There are towns where farmers have smudged, roped, discharged fire-arms, and rattled tin pans, until straw stacks and patience were exhausted; and all to no avail. Others have worked hard smoking and roping their fields, supposing all the while that they were accomplishing something, only to find in the end that they were worse off than neighbors who had done nothing. Others, who have had plenty of straw at hand, have, by firing it at just the right moment, managed to save a field. But the uselessness of all such attempts has generally been too apparent to encourage any hope of even a chance of success.

### BURNING PRAIRIES.

The amount of help which may be received from burning the grass on the prairie at the time of hatching, seems likely to be well tested next year, as the efforts to preserve the grass have so far been generally successful. The exact amount of help that can be derived from a general burning must vary much, with differing circumstances, from one year to another, and the opinions as to its value differ greatly. To those who believe that the whole region of uncultivated prairie in the western part of the state is extensively dotted with eggs, nothing could seem more important than a general preservation of the grass, difficult or impossible as this may be. There is no question whatever as to the value ot preserving it in all cultivated neighborhoods, or in all regions

that are interspersed with farms. And yet even in these it is difficult to select a time for burning which will not allow the escape of some portions of those already hatched or of those still unhatched. But even if the help falls a great deal short of general destruction it is still a help; even if no insects are hatched on the prairie they often hop away in large numbers off the bare fields into the prairie grass, and may be destroyed in large quantities. In addition to this, where the grass is burned late in the spring it gives place to a growth of young and tender grass which often serves to entice the locusts away from the crops. In Watonwan county last year only about one half of the grass was saved through to May or June, in Cottonwood county less than one half, in Redwood, Murray and Lyon counties, hardly any. Wherever it was fairly tried in Cottonwood county, those who had charge of attending to the preservation and firing of it are strongly convinced that efficient service was rendered by it.

### PLOWING AND HARROWING.

The prevention of the eggs from hatching by deep plowing or by surface harrowing has been urged in the Report of the Omaha Conference, and none too strongly. While there is much difference of opinion in regard to deep plowing, there is strong testimony to show that where the eggs are turned under to the depth of ten inches they either never hatch at all, or come forth so late as to be incapable of harm, appearing sometimes after the corn has reached the height of three or four feet, sometimes as late as the end of August. But if there is any point in the whole subject where opinions seem to be unanimous, it is in regard to the value of harrowing up the eggs in the fall, and exposing them to the influence of weather, birds and other enemies. In this connection the general harrowing of new breaking and plowing of roadsides that have been done by many farmers, or by townships, cannot fail to be of benefit. That this work should commence in our climate as soon in the fall as there is any assurance that the egg-deposit is ended, is evident from the consideration that the longer the egg is exposed to the above mentioned influences the more sure its destruction is likely to become, and from the fact that in many places the ground became frozen before the work of harrowing was nearly finished.

### THE NEED BOTH OF STATE AND OF INDIVIDUAL EXERTION.

It will be fortunate if science and national discovery shall finally

be able to dispel for us some of the uncertainties which beset the locust problem in general. It is the doubt in regard to the future and the fear that each year may prove more disastrous than its predecessor, that give the evil more than its real magnitude and paralyze hands that are not otherwise accustomed to refuse labor. To simplify the conditions of the problem as far as possible, to determine how far the goings and comings of a fitful insect hurrying destructively over thousands of miles of grain fields, and sowing everywhere the seeds of future devastation, may be foreseen or prevented, is an object worthy of the highest science and the most liberal enterprise. But the help that can come from any such source must necessarily be long in action and slow in results. With all our uncertainties, we have one certainty before us in the immediate future; it is that of a great and wide spread injury which only prompt, efficient, concerted and continued effort can remedy. We cannot offer to do less than to render at once by ourselves and to ourselves a portion of that help which we ask a broader knowledge and enlarged means to render unnecessary in the future. The state of Minnesota has already taken the lead in the proposal of a conference upon the locust subject, which, if the results correspond in any fair measure to the objects proposed, will end in more definite knowledge and more efficient action throughout all the region that has been overrun for so many years. The state may fitly supplement the action of the conference by determining once for all just what can be done with the evil when it has taken root here. It is no longer a question that that is a state matter which concerns more or less intimately forty-four out of seventy-one counties.

But the matter does not end with the state. After all that can be done by legislation, success depends purely upon how much each man is willing to do with his own hands. Without united effort to meet the evil wherever it occurs, and with every means or instrument that lie at our disposal, without a determination to plow and sow and defend, each and every man on his own domain, nothing will be done that is worth legislating about. No effort is worth securing that does not recognize the need of the broadest possible exertion, or offer the largest possible assurance of ultimate success.

### BOUNTY.

The conference at Omaha, while recognizing the necessity for united action, both of the state and of every individual through-

out the present infested regions, resolved "That it will be wise and politic for the legislatures of each of the states and territories most deeply interested in the locust question, to enact a state bounty law," etc. As there is in the minds of many a grave doubt as to the expediency of offering any bounty at all which shall take the form of a specified amount to be paid per bushel for locusts, and as it will be difficult to enact any law which shall be equally adapted to the thickly settled counties and the thinly settled frontier, I have included in circulars to the different towns the question, "If a bounty were offered in your township, next spring, for the destruction of locusts, could it be made to any extent successful in saving crops?" and "How small a price per bushel would accomplish the purpose?" The farmers ought to know at least as well as any one the capabilities of their own communities, and it is some proof of the sincerity with which they have made their replies, that in counties where the locust is comparatively unknown, it is answered that they are unable to give an opinion; in the sparsely settled counties, the fear is often strongly expressed that such a bounty would be useless for the purpose stated; while in those counties where the locusts have hatched of late years or where the bounty system has already been applied, it is considered that a bounty per bushel would undoubtedly accomplish the object named. The amount is generally placed at one dollar per bushel, seldom more, and often one-third or one-fourth of that amount; and while one dollar per bushel might be none too great a price per bushel for locusts immediately after hatching, it is certain that in a very few days a much smaller amount would more than equal it.

By referring to the experience of Mr. Andrew Webster, already given, it will be seen that from the 11th of June to the first of July, even ten cents per bushel would have been a paying bounty, when added to the crop that was saved by the exertions made in catching. With the improved machines and contrivances for capturing that are being brought forward at this date (Jan. 30, 1877) it is certain that the state need not offer a larger bounty, at the utmost, than ten cents per bushel after the tenth of June. If the locusts exist in sufficient numbers to do great injury after that date, a few cents per bushel added by counties, or by towns, to the amount given above, will make a bounty that will amply repay labor, to say nothing of the saving in crops. It would be also an improvement, both in convenience and exactness, if a bounty were offered per pound, instead of per bushel. It is no pleasant matter to measure a few bushels of locusts that have been standing for a

day or two under a hot June sun, and the hurry of an unpleas task may be a cause of inaccuracy in measurement; but the mea ure in pounds of almost any quantity of dead locusts can be ob tained at once, with ease and accuracy.

### CONCLUSION.

In conclusion it remains to thank the many persons, both kno and unknown to me, who have so kindly replied to my circula and letters of inquiry during the season. The writers are many that it is impossible to name them, but they have hel greatly to give this report whatever value it may have. Th value must necessarily appear different to different readers ; ma will miss what they expected to find, or find what may appear comparative little value. But I have endeavored to compile fr all available sources what might be of benefit to our citizens a at the same time worthy of appearance in a report upon the N ural History of the State ; I have tried to show not only t requirements of the present year in meeting the locust evil as w find it upon us now, but also the connection between one ye and another. But whatever the value of the report may be, th State should provide fitting means for the continuance of simil (or better) efforts during the year 1877. Not only is an enterpri of this sort, if properly conducted, always a worthy one in an State which labors under an evil of such magnitude, but the he which a national commission may derive from assistants acti under its direction in every one of the States now infested m be of great value, and will help to bring completeness to a ta which any commission will find too widely extended to reach wi personal observation. There is no need to regret the triflin sums which have so far been expended upon "grasshopper inve tigations," nor to begrudge the few hundred dollars that wi enable us to do what little we can in aid of that scientific inqui for which we now ask of the National Government compete maintenance and the best learning that America can supply.

Respectfully submitted.

ALLEN WHITMAN.

# VIII.

# THE GEOLOGY OF HENNEPIN COUNTY.

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*Situation and Area.*

Hennepin county lies west of the Mississippi river, and in the angle formed by the Minnesota and the Mississippi. It extends thirty miles north and south and about the same distance east and west, but its form is more that of a square with rounded corners. Its aggregate area is 354,904. 96 acres, as follows, by towns. This tabulated statement was furnished by Mr. F. E. Snow, under the direction of Sur. Gen. J. H. Baker, St. Paul.

*Surveying Statistics of Hennepin County, Minnesota.*

| Township. | Range. | TOWNSHIP LINES. When Surveyed. | | SUBDIVISIONS. When Surveyed | Acres. | Remarks. |
|---|---|---|---|---|---|---|
| 27 | 23 | ........ | ........ | ........ | ........ | Frac'l Ft. Snell. Res'n. |
| 28 | 23 | N. & W. | July, 1853. | August, 1853. | 1,804.67 | " " " |
| 29 | 23 | N. E. S. W. | Oct., 1847. | Oct. Nov., 1847. | 8,126.94 | East of Miss. River. |
| 29 | 23 | S. & W. | July, 1853. | July, 1853. | 434 62 | West of Miss. River. |
| 27 | 24 | N. E. W. | July, 1853. | August, 1853. | 14,251 79 | Frac'l Minn.R.& Res'n |
| 28 | 24 | N. E. S. W. | July, 1853. | August, 1853. | 19,671 79 | Frac'l Ft. Snell. Res'n. |
| 29 | 24 | N. & E. | Oct., 1847. | Nov., 1847. | 5,674.58 | East of Miss. River. |
| 29 | 24 | N. E. S. W. | July, 1853. | July, Aug., 1853. | 16,268.72 | West of Miss. River. |
| 115 | 21 | E. | July, 1853. | Sept., 1854. | 1,374.75 | Frac'l Minn. River. |
| 115 | 21 | N. & W. | Sept., 1854. | ........ | ........ | |
| 116 | 21 | E. | July, 1853. | Oct., 1854. | 8,674.30 | Frac'l Bal. 4th P. M. |
| 116 | 21 | N. | Oct., 1853. | ........ | ........ | |
| 116 | 21 | S. W. | Sept., Nov., 1854. | ........ | ........ | |
| 117 | 21 | E. | July, 1853. | Nov., 1854. | 9,654.96 | Frac'l Bal. 4th P. M. |
| 117 | 21 | S. | Oct., 1853. | ........ | ........ | |
| 117 | 21 | N. & W. | Nov., 1854. | ........ | ........ | |
| 118 | 21 | S. & E. Frac'l | July, 1853. | Oct., 1855. | 13,654.25 | Frac'l Bal. 4th P. M. |
| 118 | 21 | N. S. W. | May, 1855. | ........ | ........ | |
| 119 | 21 | N. S. W. | May, 1855. | July, 1855. | 20,274.59 | Frac'l Miss. River. |
| 120 | 21 | S. & W. | May, 1855. | July, 1855. | 8,371.20 | Frac'l Miss. River. |
| 115 | 22 | N. E. W. | Sept. Oct. Nov., 1854. | Oct., 1854. | 62.95 | Frac'l Minn. River. |
| 116 | 22 | N. | Oct., 1853. | Oct., 1854. | 19,769.41 | Frac'l Minn. River. |
| 116 | 22 | S. E. W. | Nov., 1854. | Oct. Nov., 1854. | ........ | |
| 117 | 22 | S. | Oct., 1853. | Nov., 1854. | 21,877.28 | |
| 117 | 22 | N. E. W. | Nov., 1854. | ........ | ........ | |
| 118 | 22 | N. E. S. W. | May, 1855. | August, 1855. | 21,487.87 | |
| 119 | 22 | N. E. S. W. | May, 1855. | Sept., 1855. | 21,639.66 | [& Crow Rivers. |
| 120 | 22 | N. | Oct., 1853. | Sept., 1855. | 16,823.08 | Estimated Frac'l Miss. |
| 120 | 22 | S. E. W. | May, 1855. | ........ | ........ | [& Crow Rivers. |
| 121 | 22 | S. | Oct., 1853. | Sept., 1855. | 202.30 | Estimated Frac'l Miss. |
| 121 | 22 | W. | May, 1855. | ........ | ........ | |
| 117 | 23 | S. | Oct., 1853. | Nov., 1854. | 12,312.62 | |
| 117 | 23 | N. E. W. | Nov., 1854. | ........ | ........ | |
| 118 | 23 | N. E. S. W. | May, 1855 | July, 1855. | 21,599.26 | |
| 119 | 23 | N. E. S. W. | May, 1855. | June, July, 1855. | 22,980.48 | |
| 120 | 23 | S. E. W. | May, 1855. | Oct., 1855. | 16,538.32 | Est'd Frac'l Crow Riv. |
| 121 | 23 | E. | June, 1855. | July, 1855. | 22.00 | " " " " |
| 117 | 24 | S. & W. | Oct., 1853. | June, 1855. | 18,729.09 | |
| 117 | 24 | E. | Dec. 1854. | ........ | ........ | |
| 117 | 24 | N. | May, 1855. | ........ | ........ | |
| 118 | 24 | W. | Oct., 1853. | June, 1855. | 21,463.03 | Est'd Frac'l Crow Riv. |
| 118 | 24 | N. E. S. | May, 1855. | ........ | ........ | |
| 119 | 24 | N. S. E. | May, 1855. | June, 1855. | 13,841.54 | Est'd Frac'l Crow Riv. |
| 120 | 24 | E. & S. | May, 1855. | Oct., 1855. | 444.50 | " " " " |

**Total surveyed area..........................347,928.90 acres.**

The following is the area of the unsurveyed portion of the Fort Snelling Reservation, as estimated by Mr. F. E. Snow:

**Tp. 27, Range 23.......................................... 760.00 acres.**
**Tp. 27, Range 24.......................................... 464.44 acres.**
**Tp. 28, Range 23..........................................4,334.24 acres.**
**Tp. 28, Range 24..........................................1,417.38 acres.**

**Total..........................................6,976 06 acres.**

## *Natural Drainage.*

Nearly three-fourths of the boundary of this county is formed

by rivers. The Mississippi is along the northeast, the Minnesota is along the south and southeast, and Crow river runs along the northwest. It has numerous lakes of clear water, and small streams that flow from the central or southwestern portions outward, in nearly all directions, but no large streams enter the county, except where the Mississippi intersects the city of Minneapolis. Lake Minnetonka is a large and irregular expanse of water, in the southwestern part of the county, with high shores and knolls of drift on all sides, navigable for small steamers of which there are already five on the lake. The frequency of lakes throughout the county is one of its most noticeable features. They are generally surrounded by high drift hills, and have deep water, and gravelly shores. Steamers ply on the Mississippi above the Falls of St. Anthony, and also below, though the rapids below the Falls, extending about a mile, and the rapids at Meeker's Island, about three miles below the Falls, prevent the general navigation of the river within the limits of the county. The Minnesota river is also navigable throughout its extent in Hennepin county. In the north central portion of the county are several extensive marshes, about the headwaters of some of the streams running north, and extending along their valleys.

*The Surface Features.*

The most of the county has an undulating or rolling drift surface, and a nearly level general contour. The Mississippi river has modified the drift in a wide belt of country along both sides, but especially on the west side, within Hennepin county, making the surface nearly flat, with a lighter, or more sandy soil. This belt of flat land, on the west side, is markedly set off from the rolling portion of the county by a line which nearly coincides, through Dayton, Champlin and Brooklyn, with the supposed boundary line between the St. Peter sandstone and the lower magnesian formation. In the northern part of Crystal Lake this line changes its direction, and approaches rapidly toward the river, entering the corporate limits of the city of Minneapolis in Sec. 16. It then strikes nearly south, running along the west side of Lakes Calhoun and Harriet; then east toward the river, keeping on the east of Lakes Amelia and Mother, after passing which it strikes rapidly toward the west and southwest to Sec. 33, in Richfield township, when it turns nearly south; and in Sec. 16, Bloomington, it coalesces with a similar line which follows the Minnesota river. The belt of land thus set off, is generally flat and often sandy or

gravelly with only an occasional knoll of hardpan drift. At some depth below the surface the hardpan drift is uniformly met with in all excavations. This flat tract is, in its widest parts, six miles across from east to west. The narrowest point is in N. Minneapolis where it is less than a mile across. A similar flat belt runs along the east side of the river in Anoka and Ramsey counties. This land is at the present time never reached by even the highest freshet stage of the river. There is *within* the flat tract, along the river, a flood-plain level, subject to annual overflow. If ever the river operated over this belt so as to affect its topography, it must have been at a time when it was of vastly greater volume than at present, and probably during the period of recession of the ice of the last glacial epoch, and while the material of the drift was itself being deposited. This tract is underlain in some places by a laminated clay, which, when burned for brick, makes the well-known "Milwaukee brick" which are of a light buff or cream color.

The elevation of the county above the ocean is, perhaps on an average, about one thousand feet. The following points have been determined.

*Elevations in Hennepin County.*

| | Above the Ocean. |
|---|---|
| St. Anthony Junction, St. P. & P. R. R. | 829 feet. |
| Mississippi (low water) at Nicollet Island | 791 feet. |
| Minneapolis Junction, St. P. & P. R. R. | 821 feet. |
| Mississippi (low water), half a mile below St. Anthony Falls | 711½ feet. |
| Self's Lake (water), St. P. & P. R. R. | 842 feet. |
| Wayzata Station, St. P. & P. R. R. | 922 feet |
| Lake Minnetonka (water) | 913 feet. |
| Long Lake Station, St. P. & P. R. R. | 940 feet. |
| Anoka, (opposite Champlin,) St. P. & P. R. R. | 869 feet. |
| Minneapolis Depot, M. & St. P. R. R. | 816 feet. |
| Minnehaha Creek, (bottom,) M. & St. P. R. R. | 792 feet. |
| Minnehaha Creek, grade of M. & St. P. R. R. | 806 feet. |
| Minnehaha Station, M. & St. P. R. R. | 802 feet. |
| Fort Snelling Station, M. & St. P. R. R. | 712½ feet. |
| Bottom of Minnesota river, at crossing of M. & St. P. R. R. | 663 feet. |
| Bridge at crossing of Minn. R. at Ft. Snelling, M. & St. P. R. R. | 708½ feet. |

*Elevations on the Minneapolis & St. Louis R. R.*

FURNISHED BY COL. J. B. CLOUGH.

| [East from Minneapolis.] | Above the Ocean. |
|---|---|
| Crossing of St. P. & P. R. R., near St. Anthony Junction | 828 feet. |

| | | | |
|---|---|---|---|
| 140 "stations" east of crossing,* (cut of 7 feet,) | Rolling surface. | 938 feet. |
| 220 "stations" east of crossing, (cut of 16 feet,) | | 913 feet. |
| 240 "stations" east of crossing, (track,) Robinson L. | | 906 feet. |
| 240 "stations" east of crossing, water surface, Robinson L. | | 898 feet. |
| 265 "stations" east of crossing, (cut of 7 feet) | | 917 feet |
| 300 "stations" east of crossing, (track,) Bennett L. | | 885 feet. |
| 300 "stations" east of crossing, water surface, Bennett L. | | 883 feet. |
| 300 "stations" east of crossing, bottom, Bennett L. | | 868 feet. |
| 308 "staitons" east of crossing, clay ridge, (cut 20 feet,) | | 888 feet. |
| 320 "stations" east of crossing, track, (cut 18 feet,) | | 897 feet. |
| 405 "stations" east of crossing, track at Owassa L. | | 888 feet. |
| 405 "stations" east of crossing, bottom, Owassa L. | | 871 feet. |
| 405 "stations" east of crossing, water surface Owassa L. | | 878 feet. |
| 415 "stations" east of crossing, track, (cut 17 feet,) | | 897 feet. |
| Tamarack Swamp, ("no bottom,") track | | 873 feet. |

[NOTE.—This swamp seems to consist of a mass of floating peat, grass-roots, &c., supporting small tamarack trees. Three piles were driven (spliced), each 60 feet long, making 180 feet, without reaching solid foundation. The track was then supported on a raft consisting of logs, slabs and brush thrown on the surface, and remains so still.]

| | | |
|---|---|---|
| 465 "stations" east of crossing, track | Rolling. | 873 feet. |
| 465 "stations" east of crossing, water, (30 ft. piles driven) | | 869 feet. |
| 600 "stations" east of crossing, track, (ground on either side 30–50 feet higher) | | 931 feet. |
| 650 "stations" east of crossing, White Bear flats | | 923 feet. |
| 670 "stations" east of crossing, Junc. of L. S. & M. R. R. | | 917 feet. |
| White Bear Lake, (water,) cannot be far from | | 918 feet. |

[NOTE.—The depot at White Bear may be six or ten feet higher than the grade at this Junction.]

[South from Minneapolis.]

| | |
|---|---|
| Minneapolis & St. Louis Depot, Minneapolis, cor. 2d street and 4th avenue | 816 feet. |
| Crossing of Hennepin avenue, foot of Bridge street, at the old suspension bridge | 803 feet. |
| St. Paul & Pacific Depot, Minneapolis | 821 feet. |

[The line, to Cedar Lake, follows the valley of Basset's creek.]

| | |
|---|---|
| Cedar Lake, (track) | 855 feet. |
| Cedar Lake, (water surface) | 852 feet. |
| Bass Lake, (track) | 876 feet. |
| Bass Lake, (water surface) | 868 feet. |
| Divide between Bass Lake and Minnehaha creek | 908 feet. |
| Divide between Bass Lake and Minnehaha creek, (nat. sur.) | 920 feet. |
| Marsh at Minnehaha creek, (track) | 885 feet. |
| Marsh at Minnehaha creek, (surface of marsh) | 880 feet. |

* One "station" equals one hundred feet.

| | |
|---|---|
| Crossing of Minnehaha creek, (track) | 897 feet. |
| Crossing of Minnehaha creek, (water) | 885 feet. |
| Divide east of Hopkins Station, (cut 14 feet) | 918 feet. |
| Divide between Hopkins Station and Shady Oak, (cut 18 feet) | 901 feet. |
| Shady Oak Lake, (track) | 900 feet. |
| Shady Oak Lake, (water surface) | 898 feet. |

[Piles were here driven 78 feet, to a hard bottom, which now support the track; water 20 feet; the rest mud, "or something else." Soundings at first indicated but 20 feet of water; but in filling, the bank settled at least 40 feet further; after two months' work at filling, with little visible progress, the builders had to resort to pile-driving.]

| | |
|---|---|
| Mud Lake, (track) | 898 feet. |
| Mud Lake, (water) | 890 feet. |

[Rolling Surface.]

| | |
|---|---|
| Elevation between Mud Lake and Glen Lake marsh, (cut 8 feet) | 913 feet. |
| Glen Lake marsh, (track) | 898 feet. |
| Glen Lake, (surface of marsh) | 895 feet. |

[At Glen Lake marsh, after the track was built it sank, and was entirely lost, a lake being formed. Then piles were resorted to, with a depth of 50 feet, for a distance of 250 feet.]

| | |
|---|---|
| Divide 1,000 feet west of Glen Lake marsh, (cut 18 feet) | 908 feet. |
| Rolling descent to— | |
| Island Lake, (track) | 898 feet. |
| Island Lake, (water surface) | 881 feet. |
| Divide 1,000 feet west of Island Lake, (track; no cut) | 903 feet. |

[On the east side of the line hills rise 75 or 100 feet higher, the road running through a gap; on the west side hills rise 30 or 40 feet. At 1,500 feet further south the road passed through a ridge of gravel and red clay (mixed) in which was found a piece of native copper weighing 78 pounds. This was a cut of 30 feet.]

| | |
|---|---|
| Purgatory creek crossing, (track) | 844 feet. |
| Purgatory creek crossing, (ground) | 828 feet. |
| Purgatory creek crossing, (bottom) | 820 feet. |

[Piles were driven here 36 feet without finding a hard bottom.]

| | |
|---|---|
| Eden Prairie Station, (8 feet cut) | 873 feet. |
| Divide between Eden Prairie Station and Lake Bradford, (cut 8 ft.) | 891 feet. |
| Lake Bradford, (track) | 863 feet. |
| Lake Bradford, (water) | 855 feet. |
| Elevation at county line, (Hennepin and Carver; track) | 865 feet. |
| Elevation at county line, Hennepin and Carver, (Nat. Surface) | 895 feet. |

[At 1,000 feet west of the county line is a cut of 40 feet.]

| | |
|---|---|
| Ravine 2,000 feet west of last cut, (track) | 836 feet. |

[Trestle work is built here 75 feet high, and 450 feet long; stiff clay on the west side of the ravine and sand on the east side. Sudden changes occur in the drift in going down to the Minnesota valley.]

| | |
|---|---|
| One mile further on, ravine, (track)........................ | 791 feet. |
| One mile further on, ravine, (bottom)........................ | 726 feet. |
| Foot of the Minnesota river bluffs, near Chaska................ | 742 feet. |

[Then comes a quaking, or peaty, marsh for 3,000 feet.]

| | |
|---|---|
| Crossing of Hastings and Dakota R. R., Chaska ............... | 716 feet. |
| Carver Station, (12 feet fill)................................ | 710 feet. |
| Minnesota river crossing, (track)............................. | 716 feet. |
| Botton of Minnesota river, (Carver)........................... | 678 feet. |
| Water in Minnesota river, (Carver)............................ | 683 feet. |
| Sioux City Junction............................................ | 753 feet. |

*Description of the towns of Hennepin county.*

In the following notes on the various towns of the county the magnetic variation given is that recorded by the U. S. Surveyors on the township plats:

TOWNS 27 AND 28, R. 23 W. OF 4TH PRIN. MER. (*Fractional.*) *E. parts of* RICHFIELD *and* MINNEAPOLIS.

These embrace the bluffs of the Mississippi and Minnesota rivers south of Minneapolis, and a narrow strip of level and prairie land along the west side of those rivers above the point of their confluence, not exceeding two miles in width.

T. 29, R. 23 W. OF 4TH PRIN. MER. (*Fractional.*) *E. part of* ST. ANTHONY.

This is a belt of one mile wide embracing six sections, and lies mostly on the east side of the Missitsippi river. It is all included within the prairie land that characterizes the Mississippi valley, except about a mile square in its northern portion, which is rolling and wooded.

T. 27, R. 24 W. OF 4TH PRIN. MER. (*N. of the Minnesota.*) *E. part of* BLOOMINGTON.

By far the larger portion of this town is prairie, lying in the northeastern portion. Along the southern side the bluffs of the

Minnesota river are rarely rocky, but usually turfed and frequently timbered. The bottom lands sometimes embrace large water areas, and are very wide, the bluffs running from one-half mile to a mile from the river channel. The timber is generally light, except a small area in the northwest corner of the town. The town has several small lakes in the uplands.

T. 28, R. 24 W. OF 4TH PRIN. MER. *Central part of* RICHFIELD *and northern part of* MINNEAPOLIS.

The central and northern portions of this town are rolling, and contain numerous lakes, such as Wood, Grass, Mother, Amelia, Calhoun, Harriet, Diamond, Pearl, Rice, Duck and Mud. This rolling tract is crossed by Brown Creek (now known as Minnehaha Creek). Toward the northeast and southeast are patches of level prairie.

T. 29 N., R. 24 W. OF 6TH PRIN. MER. *E. part of* MINNEAPOLIS.

This town embraces the city of Minneapolis, on both sides of the river, and the Falls of St. Anthony. The largest part of the town is flat, and the southeastern portion contains prairie belts, particularly on the west side of the Mississippi river, within the ancient drift bluffs of the river. The western portions, and a small area in secs. 1 and 12, are rolling and timbered, with lakes. There are also small areas of swamp, the largest being east of the Mississippi river in secs. 12, 13 and 24. Bassett's Creek breaks the surface in the central part of the town on the west side of the river, entering the Mississippi about a mile above the Falls. Mag. var. 9°, 39' to 11°, 20'.

TOWNS 115 AND 116 N., R. 21 W. OF 5TH PRIN. MER. (*Fract.*) *W. part of* BLOOMINGTON, *and S. W. part of* RICHFIELD.

This embraces a little prairie tract in the southern portion, and several lakes in the northern, but it is mostly undulating and timbered. The Minnesota bluffs bound it on the south, but they are not rocky. They rise about 150 feet above the river. In the northern portion are some high drift-knolls. Anderson lake is the principal body of water. Mag. var. 10° to 12°, 30'.

TOWNS 117 AND 118 N., R. 21 W. 5TH PRIN. MER. (*Fractional.*) CRYSTAL LAKE, *with parts of* MINNEAPOLIS *and* RICHFIELD.

This is entirely a wooded and undulating or rolling tract, run-

ning N. and S., about $2\frac{1}{2}$ miles wide, and east to the Mississippi north of Minneapolis. It has small marshy areas, and one irregular patch of prairie northwest of Minneapolis city. Mag. var. 10°, 5' to 11°, 53'.

T. 119 N., R. 21 W. 5TH PRIN. MER. BROOKLYN.

This town is altogether level, except in the southwest corner, and is mainly one of prairie. The scattered timber is small. Palmer Lake is in Sec. 26, and through it runs Shingle creek, which is accompanied by some marsh. The Mississippi river forms the eastern boundary, but the bluffs are low and consist of drift only. A belt of heavier timber skirts the river in the northeastern portion of the town. Mag. var. 10° 45' to 12° 39'.

T. 120 N., R. 21 W. 5TH PRIN. MER. *E. part of* CHAMPLIN.

There is a small area lying on the Mississippi river, having a variety of surface, flat prairie, timbered bottom land, and lightly timbered upland.

T. 116 N., R. 22 W. 5TH PRIN. MER. EDEN PRAIRIE.

While this town is mainly rolling or hilly, with lakes and some marshes, and heavily timbered, it took its name from a flat prairie which lies in the southern portion, bordering on the Minnesota river, including the bottom land and a belt about a mile wide north of the bluffs. Mag. var. 10° to 13° 57'.

T. 117 N., R. 22 W. 5TH PRIN. MER. MINNETONKA.

This town is wholly wooded and rolling, some parts being hilly. It also has small areas of marsh, intervening between the drift hills, and occasional lakes, the largest body of water being a part of Minnetonka Lake, from which flows Little Falls creek, (known now as Minnehaha creek,) and crosses the center of the town easterly. Mag. var. 10° 9' to 14° 45.

T. 118 N., R. 22 W. 5TH PRIN. MER. PLYMOUTH.

This is also a rolling and timbered town, with several lakes and tamarack swamps. Medicine Lake in the S. E. corner is the largest body of water. Mag. var. 11° 21' to 14° 45.

T. 119 N., R. 22 W. 5TH PRIN. MER. MAPLE GROVE.

The town is entirely rolling and wooded, except a small portion in sections 1, 12 and 13, which is an extension of the Brooklyn prairie. It is crossed by a small creek running N. through the center, and by its tributary in the N. W. It contains several fine lakes. Mag. var. 9° 45' to 12° 38'.

T. 120 N., R. 22 W. 5TH PRIN. MER. DAYTON, *and W. part of* CHAMPLIN.

This town resembles the last, but borders on the Mississippi river, which has drift-banks that rise about 100 feet above the river. Crow river also touches it on the north. Mag. var. 9° 45 to 12°.

T. 117 N., R. 23 W. 5TH PRIN. MER. EXCELSIOR, *and part of* MEDINA, *and part of* MINNETONKA.

About one-half of this town is covered with water, pertaining to Lake Minnetonka. The rest is rolling and heavily timbered, with occasional marshes. Mag. var. 11° 15' to 13° 12'.

T. 118 N., R. 23 W. 5TH PRIN. MER. *N. part of* MEDINA.

This town is much diversified with lakes, marshes, and a rolling surface. It is entirely wooded. Mag. var. 10° 20' to 13° 12'.

T. 119 N., R. 23 W. 5TH PRIN. MER. CORCORAN.

A wooded, rolling town, with frequent small marshes and two or three lakes. Mag. var. 10° 40' to 11° 45'.

T. 120 N., R. 23 W. 5TH PRIN. MER. (*S. of Crow River.*) HASSAN.

This is a wooded, rolling town, similar to the last, but has Crow river along its northern boundary. Mag. var. 9° 13' to 11° 30'.

T. 117 N., R. 24 W. 5TH PRIN. MER. MINNETRISTA.

This is a rolling timbered town embracing a part of Lake Min-

netonka, and several smaller lakes, as well as numerous marshes. Mag. var. 10° 40' to 13° 12'.

T. 118 N., R. 24 W. 5TH PRIN. MER. INDEPENDENCE.

This is a rolling timbered town, dotted with small marshes and lakes. Mag. var. 10° 5' to 12° 30'.

T. 119 N., R. 24 W. 5TH PRIN. MER. (*S. of Crow River.*) GREENWOOD.

Crow river, which crosses this town, separates Greenwood from Wright county. It is in every respect similar to those already described. Mag. var. 10° 25' to 10° 12'.

*Soil and Timber.*

The most of the county has a close, clay soil of a grayish color. This is particularly the case in the heavily wooded portion. At least three-quarters of the county are embraced under this description. The soil of the eastern quarter of the county is more sandy. The change from clay to sand, while in general taking place along the boundary line already defined under the head *Surface Features*, still is not always abrupt. It is always accompanied by a change of timber species. In the clay land are found sugar maple, elm, bass, butternut, and a variety of others, while in the sandy or loam covered portions are found only oaks and aspens which generally are also quite small. The belt containing this small, sparse timber runs north and south across the eastern portion of the county covering the eastern part of Maple Grove, the eastern part of Plymouth, the western part of Minneapolis and the central portions of Richfield and Bloomington, with isolated areas in Minnetonka and Eden Prairie. This feature in the forest of the county gradually dies out toward the east, and most noticeably after passing the boundary between the rolling surface and the flat land along the Mississippi; the country becoming nearly a continuous and open prairie. Throughout this belt of sparse and small timber there are occasional large bur oaks on the uplands, and also occasionally gigantic black oaks, with charred trunks, in clusters, having no other company than an undergrowth of oak bushes. There are also, in the bottom land along some of the ravines, occasional trees of elm or bass. The eastern boundary of the heavily tim-

bered rolling area, with a distinctively clay soil, strikes the Mississippi river about three miles southeast of Dayton.

The following species of trees and shrubs are known to grow in the county. The trees are named in the estimated order of abundance:

American Elm. Ulmus Americana, L. (*Pl. Clayt.*) *Willd.*
Bass. Tilia Americana, L.
Sugar Maple. Acer saccharinum. *Wang.*
Red Oak. Quercus rubra. *L.* (*?*)
Butternut. Juglans cinerea. *L.*
Bur Oak. Quercus macrocarpa. *Michx.*
Red Elm. Ulmus fulva. *Michx.*
Soft Maple. Acer rubrum. *L.*
Bitternut. Carya amara. *Nutt.*
White Ash. Fraxinus Americana. *L.*
Black Oak. Quercus tinctoria. *Bart.* (*?*)
Ironwood. Ostrya Virginica. *Willd.*
Black Ash. Fraxinus sambucifolia. *Lam.*
Wild Plum. Prunus Americana. *Marsh.*
June-berry. Amelanchier Canadensis. *Var.* Botryapium. *Torr. & Gr.*
American Crab-Apple. Pyrus coronaria. *L.*
Aspen. Populus tremuloides. *Michx.*
Tamarack. Larix Americana. *Michx.*
Box Alder. Negundo aceroides. *Mœnch.*
Great-toothed Poplar. Populus grandidentata. *Michx.*
Black Cherry. Prunus serotina. *Ehr.*
Cottonwood. Populus monilifera. *Ait.*
Water Beech. Carpinus Americana. *Michx.*
Willow. (*Salix.*)
Hackberry. Celtis occidentalis. *L.*
White Birch. Betula alba. *Var.* populifolia. *Spach.* (*?*)
White Oak. Quercus alba. *L.*
Red Cedar. Juniperus Virginiana. *L.*
White Pine. Pinus Strobus. *L.*

A few trees of white pine occur on Minnehaha creek, and at Dayton.

### *Shrubs and Woody Vines.*

Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Bittersweet. Celastrus scandens. *L.*
Frost Grape. Vitis cordifolia. *Michx.*
Hazel. Corylus Americana. *Walt.*
Smooth Sumac. Rhus glabra. *L.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*

Wolf-berry. Symphoricarpus occidentalis. *R. Br.*
Black-cap Raspberry. Rubus occidentalis. *L.*
High Blackberry. Rubus villosus. *Ait.*
Red Raspberry. Rubus strigosus. *Michx.*
Choke Cherry. Prunus Virginiana. *L.*
Thorn. Cratægus coccinea. *L.*
Rose. Rosa lucida. *Ehr.*
Prickley Ash. Zanthoxylum Americanum. *Mill.*
Staghorn Sumac. Rhus typhina. *L.*
Wild Rose. Rosa blanda. *Ait.*
Round-leaved Cornel. Cornus circinata. *L'Her.*
Common Elder. Sambucus Canadensis. *L.*
High-bush Cranberry. Viburnum Opulus. *L.*
Black Currant. Ribes floridum. *L.*
Alternate-leaved Cornel. Cornus alternifolia. *L.*
Panicled Cornel. Cornus paniculata. *L'Her.*
Red-osier Dogwood. Cornus stolonifera. *Michx.*
Speckled Alder. Alnus incana. *Willd.*
Sheep-berry. Viburnum Lentago. *L.*
Elder. Sambucus pubens. *Michx.*
Honeysuckle. Lonicera parviflora. *Lam.*
Honeysuckle. Lonicera ciliata. *Muhl.*
Yellow Honeysuckle. Lonicera flava. *Sims.*
Kinnikinnick. Cornus sericea. *L.*
Dwarf Cornel. Cornus Canadensis. *L.*
Prickly wild Gooseberry. Ribes Cynosbati. *L.*
Smooth wild Gooseberry. Ribes rotundifolium. *Michx.*
Ninebark. Spiræa opulifolia. *L.*
Meadowsweet. Spiræa salicifolia. *L.*

## THE GEOLOGICAL STRUCTURE.

The only rocks seen in actual outcrop within the county are those belonging to the Trenton limestone, and the St. Peter sandstone; but the Shakopee limestone (of the Lower Magnesian formation) is seen in outcrop at Shakopee, on the opposite side of the Minnesota river, and must exist in the immediate bluffs of the Minnesota river in the southwestern portion of the county. It is very likely also that large areas of the Cretaceous formation exist within the county, though its presence is only known by the abundance of Cretaceous *debris* that is found in the drift throughout the county. The geology of the county then may be embraced in the following list of formations:

1. The Drift and the loess loam.

2. The Cretaceous.
3. The Green Shales and Trenton Limestone.
4. The St. Peter Sandstone.
5. The Shakopee Limestone (of the Lower Magnesian.)

The respective areas of the Trenton, St. Peter and Lower Magnesian, are represented on the accompanying colored map of the county, so far as those areas can be ascertained or estimated. It must be borne in mind that there are no outcrops of rock in the county except along the valley of the Mississippi river, and that hence the boundary lines as laid down are not intended to express anything more than an approximation to their actual positions.

*The Shakopee Limestone.*

The reader is referred to earlier reports for the details of lithology and special characters of this limestone. It is sufficient here to say that it is named from the city of Shakopee, in the Minnesota valley, where it was first recognized as a different limestone from that along the bluffs of the Mississippi river below Hastings; and that it is the uppermost member of the *Low. Magnesian* series. It lies just below the sandstone which is seen at the Falls of St. Anthony, and is known as the "Kasota stone" among builders when wrought at Kasota, a few miles above Shakopee, in the Minnesota valley. It is strictly *an arenaceous dolomite* of a buff color varying to pinkish, or "fawn-colored," as described by Featherstonhaugh. Its thickness is about seventy feet. There is no known outcrop of it within the limits of Hennepin county, but it certainly underlies a belt of territory running northward from Shakopee and Bloomington, toward Dayton, through the central part of the county. Were it not for the heavy covering of drift, it might be expected in outcrop about the shores of Minnetonka Lake.

*The St. Peter Sandstone—Its Area.*

This well known formation is seen in the bluffs of the Mississippi river at and below the Falls of St. Anthony to the mouth of the Minnesota, and exists also in the Minnesota river bluffs for several miles above Fort Snelling; though, for reasons which pertain to the history of the Minnesota river and its age as compared with that of the Mississippi in this vicinity, it is but rarely exposed in the bluffs of that river above Fort Snelling.

The slopes from the upland to the river level, along the Minnesota, are uniformly smoothed over by the drift, and are turfed or wooded; but the descent from the upland to the river along the Mississippi, above Fort Snelling, is perpendicular and rocky, the river running in a canon-like gorge. Owing to a dip of the rocks toward the east, the St. Peter sandstone is brought above the level of the Mississippi at points above the Falls of St. Anthony, within the immediate river valley. On the east side of the river it outcrops along Main street, and is struck by digging wells at points further north and east. It underlies a belt of country running north and south across the county, next east of that of the Shakopee, which is probably about six miles wide. In the vicinity of the Falls of St. Anthony the St. Peter is also caused to be the surface rock by the cutting through of the over-lying Lower Trenton by the ancient drainage-courses of the Mississippi, or of its tributaries. Thus there is a break in the continuity of the Trenton where Bassett's creek enters the Mississippi, above the falls. That stream runs at no point over the Trenton limestone, but over the St. Peter sandstone. The valley in which it lies was cut by some more powerful force than the creek itself, and perhaps by the Mississippi river before the last drift epoch. At that time the Mississippi must have reached the Minnesota valley at some point above Fort Snelling, without running over the Trenton limestone at all, and hence without causing any falls. The width of the St. Peter area in the immediate river valley, *above the falls*, as compared with that in the same valley *below the falls*, considered in connection with the Bassett's-creek St. Peter area, clearly points to the ancient continuation of the Mississippi valley southward by the way of Bassett's creek, to the Minnesota, instead of by way of Fort Snelling. There is another break in the overlying Trenton on the east side of the river, leaving the St. Peter as the surface rock, in a low tract of land in the First Ward, northwest from the Cemetery. This low area is crossed by the Branch Line of the St. Paul & Pacific railroad longitudinally. This area of the St. Peter becomes quite narrow near the St. Anthony Junction, but rapidly widens out toward the south and east, so far as can be judged from the topographical features and from information gathered from dug wells. Just how far this St. Peter area extends south under the extensive peat marsh which covers a large tract in that direction, it is impossible to say; but the Trenton replaces it, at the surface, within a mile, since it occupies the river bluffs uninterruptedly from Fort Snelling to the

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Falls of St. Anthony, and since Tuttle's brook passes over it in joining the Mississippi near the University.

*Its Lithological Characters.*

The outward, and also the chemical, characters of this sandstone, in Minnesota, are, so far as seen, remarkably constant and simple. It is white, "saccharoidal," friable, non-fossiliferous, (or almost so,) and consists almost entirely of pure quartz sand. It contains not enough lime to act as a cement, and hence can almost everywhere be excavated even with the fingers. On exposed surfaces, as along the bluffs of the Mississippi, where dripping water passes over it, the grains become more firmly cemented together by deposition of carbonate of lime and iron oxide, and its delicate whiteness is lost. Indeed, wherever water in the smallest quantity is allowed to trickle through it, a deposit of iron oxide is invariably seen, since rarely, if ever, is any surface water found entirely free from that impurity.

The thickness of the St. Peter at the Falls of St. Anthony is 164 feet as developed by a drilled well sunk at E. Minneapolis in 1874-5; but that is considerably more than it is accredited with at points further south. At Chatfield, in Fillmore county, it is 122 feet in thickness, and in the S. W. part of Houston county it is but 75-80.

The St. Peter, operating in conjunction with the overlying Trenton limestone, is the immediate cause of a great many waterfalls. The Falls of St. Anthony are caused by the passage of the Mississippi from the limestone on to the sandstone. The latter, worn away at the foot of the fall by the retro-action of the water, leaves the limestone projecting to fall down in heavy blocks as fast as it becomes too feeble to support further its own weight. This protecting cap of limestone extends but a few rods above the present brink of the falls; and had it not been that vigorous measures were taken a few years since for its protection, it is very probable that ere this the falls themselves would have disappeared, or changed to a foaming rapid, thus destroying, or greatly damaging, one of the most important water-powers of the world. The first alarm was occasioned by the effect of the water of the river in running through an artificial tunnel in the underlying St. Peter sandstone, and the collapsing of large areas of the limestone. The water was immediately excluded from the tunnel, the sandstone behind the waterfall was protected from the retro-action of the water, and a wall or dike of concrete or *beton* was constructed

under the river in the sandrock, and below the limerock, crossing the Mississippi a short distance above the brink of the falls. This wall of concrete has a width of four feet and extends downward from the limerock to below the bottom of the river, below the falls. The chief object of this dike is to cut off all streams of water from running in the St. Peter and so perforating it and eroding it as to cause the downfall of the limerock. A number of such streams, some of considerable size, were found to be passing through the sandrock, having entered it from the river at points above the limit of the limerock. Being under considerable hydrostatic pressure their force of erosion on the sandrock was greater than ordinary surface streams of the same size. One such stream, or sheet, of water was struck by Mr. Franklin Cook, in sinking a drilled well into the sandrock at a point within the gorge some distance below the falls, when the water rose at once above the surface and has continued to flow ever since.

No fossils have been taken from this sandstone in Hennepin county ; indeed, the only trace of organic structure known to have been found in it, in the entire northwest, consists of a species of *Lingulepis*, obtained in Fillmore county, and described in the report on that county, in 1875.

## *The Trenton Limestone.*

This formation, as it occurs in Minnesota, comprises three main parts. The lowest, only, can be seen generally in Hennepin county, though that next above exists also, and is struck in wells at some distance back from the river. Those parts are—

The Upper Trenton.
The Green Shales.
The Lower Trenton.

The *Green Shales* are often called *soapstone*, but they do not contain the mineral constituents of soapstone, and should not have that name. They are about 20 feet in thickness, but being rather soft and easily covered up, they are hid by the overlying drift or loam at nearly all points along the river bluffs. Within the shales are often thin lenticular layers of very fossiliferous crystalline limestone, the upper and lower surfaces of which are literally covered with fossils in a fine state of preservation, but firmly bound to the limestone layers. There are also fossils distributed through the shales themselves, which, on the weathering of the shales, wash out in perfect preservation. *Orthis Lynx, Rhyn-*

*chonella capax* and *Chaetetes Lycoperdon*, are the most common in such conditions: but on the slabs of limestone that weather out of the shales are often a great many minute fossil forms of encrusting corals, as well as other species of brachiopods. The Green Shales may be seen at Finn's Glen, about three miles below the Falls of St. Anthony, on the east side of the river, where a little stream enters the Mississippi.

The *Lower Trenton* is typically that which occurs at the Falls of St. Anthony, and thence in the bluffs of the Mississippi to St. Paul. It has generally the following alternation of parts in descending order:

1. Impure limestone....................................9–12 feet.
2. Calcareous shale....................................4– 6 feet.
3. Argillaceous limestone.............................. 15 feet.

The above are the main distinctions as seen in Hennepin county. The characters of No. 1 are not always uniformly distributed through the whole thickness designated, but they are apt to fade out downward being replaced by some of the characters of No. 2: which also exhibits a tendency to pass gradually into the rock of No. 3. On the other hand, there is very generally a thin stratum of shale exactly like the most of No. 2, under the limerock, and lying on the St. Peter sandstone.

The following more special section will show the alternations referred to, as they appear at the quarry of E. Malony, on the east side of the river, below the University, at Minneapolis:

*Section of the Trenton below the University.*

No. 1.—Impure limestone, crystalline, rough to the touch, hard, but splitting to thin lenticular chips under the weather. This is of a blue color within, but on exposed surfaces becomes a dirty buff. The grain is close, except for the cavities resulting from absorbed fossils. The fragments into which the stone weathers out are brittle and somewhat sonorous. It is very fossiliferous especially with *Strophomena deltoidea*. It also has frequently, associated with this, *Strophomena*, a species of *Orthis*, which is perhaps *costalis*, species of *Murchisonia*, *Leperditia*, *Edmondia*, and occasionally of *Asaphus*. Thickness not fully exposed; seen about ........................................................ 8 ft.

No. 2.—Similar to the last, but gradually becoming more impure with shale, the fossils being gathered more into sheets or layers, making mere calcareous belts.................................. 2 ft.

No. 3.—Green shale, calcareous, weathering blue, with but few fossils. Occasionally is found a large specimen of *Endoceras magniventrum*, H., in this shale, the form only being preserved, surrounded by a thin black film of bituminous matter..........4 ft. 8 in.

No. 4.—The last passes gradually into a calcareous shale resembling the well-known building rock of this place, in which still there are few distinguishable fossils. This stone is sometimes used for rough walls, or in protected positions. It is markedly set off from the rock below by a projecting shoulder formed by the upper portion of No. 5......................................2 ft. 4 in.

No. 5.—The building stone of this place, and St. Paul. This stone is rather too argillaceous to be a reliable building material, yet is extensively used. The shale is intimately disseminated through the calcareous layers, without showing regular lamination, yet causes a mottled or blotched color over the surfaces when cut or broken. The darker spots are shaly; the lighter ones are more purely calcareous. The color of the whole is blue, which makes it have the appearance of strength and durability when placed in a structure. The fossil remains in this member are apt to be comminuted, so as to be wholly undistinguishable, yet sometimes large specimens of *Endoceras magniventrum*, H., are found in the layers. Rarely also, on separating the layers in quarrying, a rock-surface is disclosed that is eminently fossiliferous with forms of *Rhynchonella capax*, *Orthis*, and other brachiopods and incrusting corals. This is the principal and most constant member of the *Lower Trenton*. Thickness about............. 15 ft.

No. 6.—Blue shale, parting conchoidally under the weather, lying on the St. Peter sandstone. Seen.............................. 2 ft.

Total................................................ 34 ft.

The section exposed at the quarries on the east side of the river, at Minneapolis, is essentially the same as the foregoing, viz.:

No. 1.—"Gray rock"........................................... 8 ft.
No. 2.—"Soft stone," (shale)..... ................................. 6 ft.
No. 3.—"Blue stone".............................................14 ft.
No. 4.—Slaty clay....... ........................................ 2 ft.
No. 5.—White sandrock to the river. ...........................25 ft.

About one block above the railroad bridge over the Mississippi, at Minneapolis, the line of strike of the limerock from the north

runs down to the river, but probably crosses the river considerably further down—but a short distance above the Falls. On both sides of the river, above the Falls, the strike diverges from the actual river channel, and passes inland, nearly parallel, however, with the river, and extends some miles northwest; but below the Falls the line of strike is very near the river, and indeed constitutes the bluff of rock which encloses the gorge. The valley occupied by Bassett's creek is wider and deeper cut in the rock than that of the Mississippi below the Falls, as may be seen more clearly by consulting the accompanying map, but the line of strike of the limerock, along the creek, and along the river above the mouth of the creek, is covered by the loam deposit, which is not the case below the Falls to Fort Snelling. Below Fort Snelling the Mississippi bluffs are again covered and masked by the loam. Above the Falls the line of the edge of the limerock forms a terrace ascent facing the river, and about one-half a mile from it, and can be traced by this means on the west side of the river northward to Shingle creek, where it bears westwardly away from the river, along the south side of the creek and becomes lost by reason of the prevalence of the drift; on the east side, at about the same distance from the river, it runs northwardly across the blocks of the Second Ward and diagonally northeastwardly across the blocks of the First Ward, and returns upon itself toward the Junction of the St. Paul & Pacific R. R. Further east another area of the Low. Trenton approaches the river, and its line of strike forms a similar terrace which extends northward to the line of Anoka county and beyond. It is exposed and worked in one or two quarries situated exactly on the Anoka county line, northwest of Sandy Lake, near the railroad. It is evident from its weathered condition and stained color, although still buried under the loam, that it has been subjected, at this point, and also all along the terrace-like ascent that it forms, on either side of the river, above the falls, to the action of water, and alternating sub-ærial agencies, for a long period of time, and that perhaps it was the water of the river, in times prior to the glacial epoch that stained and shattered it. Indeed it is with some difficulty recognizable, as the same rock that forms the falls at St. Anthony, without a knowledge of its stratigraphical continuity; this is especially true of the quarries near Sandy Lake on the east side of the river.

There is a gentle dip in the layers of Lower Trenton at Minneapolis toward the southeast. At the lower, or iron, bridge it is very slight, hardly perceptible; at the falls it is about an inch in one hundred feet; it increases soon to three or four inches in one

hundred feet, and at Central Avenue, on the east side of the river, it is about five feet in one hundred feet. This dip causes the rock to rise from under the river and into the river banks, finally running in the country, as already stated, half a mile or more from the river, and more than fifty feet above it. The dip of five feet in one hundred at Central Avenue is a little away from the river, so that sewers will not empty themselves unless they are run at variance with the dip. It does not continue of the same amount but decreases northwardly, else the layers could not lie at the level they occupy where quarried at points in the north part of the city. This change may be gradual, or there may be a fault, or break, at some point in E. Minneapolis, north of Central Avenue. The St. Peter sandrock is exposed, above the level of the river, above the falls, near the upper bridge, in E. Minneapolis; and on the west side of the river, at the mill-pond at Shingle creek, two miles north of the limits of the city.

On the west side of the river the strike of the limerock, above the falls, leaves the river-bank about halfway between the railroad bridge and the mouth of Bassett's creek, sweeping round on the south side of the creek so as not to cross it, nor to be visible in its banks. It is quarried in the lumber yard opposite Boom Island, but turns from their rapidly toward the west and south, barely extending north of Sixth Avenue, North. It re-crosses the railroad between Fourth and Fifth streets, and follows the line of the road, but a block or two south of it, to the crossing of Hawthorne Avenue where it turns abruptly to the eastward, and southward along the north side of the lake in the Seventh Ward; but whether it continues in the same direction further than Nicollet Avenue, or bears more to the southward is unknown. The "hardpan" ridge crossing the south end of the Seventh Ward indicates the proximity of the strike of the Lower Trenton along the south side of the same lake, which would require an abrupt change of direction, again to the westward, or the existence of a separate area of Trenton rock lying toward the southwest. On the north side of Bassett's creek is another Trenton area, the eastern edge of which enters the city limits from the north, about one block east of Lyndale Avenue in a southwestward course, crosses Lyndale Avenue between Twenty-third and Twenty-fourth Avenues N., passes through blocks 5, 6, 7, and 8 toward the south, and again across Lyndale Avenue between Sixteenth and Seventeenth Avenues N. It crosses Plymouth Avenue two blocks east of Lyndale, and on reaching the valley of the creek it turns westward,

but its location cannot be further definitely traced owing to the prevalence of the drift, and the fact that the surface becomes one of a generally rolling character. It is tolerably certain that it does not cross the valley of Bassett's creek, but sweeps round by the west and north and unites with itself along the south side of Shingle creek, about two miles north of the city limits.

The intimate connection which the features and position of the Lower Trenton areas bear to the Post-Tertiary, about the Falls of St. Anthony, has led to a more careful study of history of the drift, and some further allusion to this formation will be found under the head of *The Drift*.

### *The Cretaceous.*

Although the Cretaceous *in situ* has not been seen in Hennepin county, it deserves to be named among the formations of the county on account of the important and conspicuous part it takes in the composition of the drift, and the strong probability that it does exist in horizontal strata below the drift in much of the western portion of the county. There is no portion of the county in which pieces of lignite from the Cretaceous have not been discovered; and throughout the rolling area, where the drift is a close clay, the color of the whole mass is frequently perceptibly tinged with green. Not infrequently pieces of green shale a foot or more in diameter are met with along the cuts by the roadside particularly in the western part of the county—disintegrated and ready to separate on the least disturbance. These of course could not have been far transported by the drift forces. The drift itself is greatly thickened by Cretaceous debris, and *is conspicuously free from foreign stones and boulders of a more enduring nature.* No other Cretaceous debris than pieces of green fissile shale and of black lignite has been recognized, and from these no fossils have been taken.

Seventeen years ago there was some excitement in the vicinity of Dayton over a reported discovery of coal, about two miles west of the village, in Wright county, by a man named Charles Williams. Upon visiting the place, the excavation was found to consist of two shafts sunk in the drift, now nearly refilled. About the place the drift thrown out shows nothing but drift clay with pebbles of all kinds and colors. One is said to have been about eighty feet deep. The general belief now is that all the coal that was found was brought for the purpose from St. Paul, as the

owner, after vainly attempting to sell his land, placed a heavy mortgage on it and abandoned the country, allowing the sale of the land for the mortgage. There is certainly now no evidence of the existence of coal, or lignite, in the vicinity, though there are traces of the Cretaceous in the drift which points to the near proximity of its layers. There is also a reported exposure of "slate" in a ravine a mile or so beyond, but it could not be found.

## NOTES ON THE DEEP WELL DRILLED AT EAST MINNEAPOLIS, MINN., IN 1874—1875.

(*From the Bulletin of the Minnesota Academy of Natural Sciences for* 1875.)

BY N. H. WINCHELL.

NATURAL SURFACE OF GROUND.

| | | | | |
|---|---|---|---|---|
| 1 | 42 | | Sand. | 42 |
| 2 | 28 | Blue. | Limestone. | 70 |
| 3 | 164 | White. | Sandstone. | 234 |
| 4 | 102 | Red. | Limestone. | 336 |
| 5 | 16 | Gray. | Limestone. | 352 |
| 6 | 116 | White. | Sandstone. | 468 |
| 7 | 128 | Blue. | Shale. | 596 |
| 8 | 82 | White. | Sandstone. | 678 |
| 9 | 170 | Blue. | Shale. | 848 |
| 10 | 9 | Sandy. | Limestone. | 857 |
| 11 | 130 | White. | Sandstone. | 987 |
| 12 | 8 | Sandy. | Marl. | 995 |
| 13 | 79 | White. | Sandstone. | 1074 |
| 14 | 57 | Red. | Marl. | 1131 |
| 15 | 290 | Red. | Sandstone? | 1421 |

The accompanying diagram of the strata passed through, with the designations of the strata, was furnished by Col. J. B. Clough, City Engineer, in whose charge the work was put by the City Council when money was appropriated to aid the enterprise. This occurred at the depth of about 1,000 feet.

No. 1. This sand is the well-known *loess loam* of the Mississippi bluffs. Though it is represented here as having a thickness of 42 feet, it shows less than one-half that thickness along the river bluff opposite the site of the well, less than 15 rods distant. It is here underlain by a heavy deposit of boulder-clay drift. It is presumable that this boulder-clay, which is itself rather sandy, was penetrated without the knowledge of the workmen, since it is seen to extend as far from the river as the site of the well along Central Avenue and on other streets, and is struck uniformly over the East Division of the city in digging wells at the depth of ten to twenty feet.

No. 2 is the *Lower Trenton Limestone,* embracing some layers of green shale, and is that which causes, in conjunction with the St. Peter sandstone (No. 3,) the Falls of St. Anthony.

No. 3 is known as the *St. Peter Sandstone.* Its thicknes, as here developed, is greater than observed at any other point in Minnesota. It is generally accredited with a thickness of about 125 feet, but here shows 164

feet. It is a purely white sand with very slight cement and very little variation in texture or grain.

No. 4 is known as the *Shakopee Limestone.* It has been placed as the uppermost member of the great Lower Magnesian Formation of Dr. D. D. Owen, but perhaps the St. Peter should be regarded as the uppermost member of that formation. Its color here appears to be nearly the same as seen at Kasota, where it is largely wrought and sold under the name of *Kasota Stone.* Its thickness, 102 feet, is greater than has been observed at any other point

No. 5 is designated a *gray limestone,* with a thickness of 16 feet. It is a new feature in the lithology of the Lower Magnesian, and may belong to the Shakopee.

No. 6. Below the *gray limestone* is a white sandstone, similar to the St. Peter above, with a thickness of 116 feet. This can be identified as the *Jordan Sandstone,* so named from Jordan village on the Minnesota river, above Shakopee, where it was first recognized as a distinct portion of the Lower Magnesian.

No. 7, which is here denominated a *blue shale* having a thickness of 128 feet, has not before been recognized as a distinct portion of the Lower Magnesian. It occupies the place, in order of stratification, of the St. Lawrence Limestone, but is not so thick.

No. 8 is likewise an unknown stratum.

No. 9, in like manner, has never before been discovered. It is highly probable that, taken together, Nos. 7, 8, 9 and 10 are the actual equivalents of the St. Lawrence Limestone in point of stratification, modified in character and increased in thickness by proximity to the ancient Laurentian belt that lies but few miles further north. This would indicate the early origin of the Minnesota spur of the old Laurentian belt or nucleus of North America, as a shore line along which shale and sand were accumulated at the same time that limestone was being formed at points more remote in deeper water.

No. 10 pertains to the same horizon, and bears a stronger resemblance to the St. Lawrence.

Nos. 11, 12 and 13 represent the St. Croix Sandstone, but it is of less thickness than where seen in the Mississippi bluffs.

No. 14 may represent the "Lingula flags," or the upper portion of the Potsdam Sandstone.

No. 15 was rather clayey to be designated, unqualifiedly, a sandstone. It is undoubtedly the upper portion of the great series of marls and sands that characterize this horizon in Minnesota, as made known by Dr. Owen, and by him and others referred to the

age of the Lower Potsdam Sandstone of New York. It seems to be the same formation in which the salt well, drilled at Belle Plaine, stopped at the depth of 710 feet, though much less compact than where it is exposed at the surface in southwestern Minnesota. It is the same formation as the rock that embraces the well-known "pipestone" or *Catlinite* of Minnesota.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, May 25, 1876.

### *The Drift.*

In Hennepin county this deposit appears under still other features than those reported from more southern counties, and considerable light is thrown on the history of that interesting epoch of geological history. Three important facts respecting it can now be considered pretty clearly established.

1st. There are two distinct glacial or hardpan deposits in Hennepin county.

2d. The limit of the ice and moving drift of the latter was, toward the east, not far from the present line of the Mississippi, between Minneapolis and Fort Snelling, passing between Minneapolis and St. Paul.

3d. The Falls of St. Anthony have receded, since the last glacial epoch, or since the retirement of the lake-like expanse of water that filled the Mississippi valley, reducing the river more nearly to its present size, only from the mouth of the Minnesota, at Fort Snelling, a distance of about nine miles.

The facts on which these conclusions are based may be grouped under three heads, as follows:

*1st. Detailed observations on the composition of the drift.*
*2nd. The geographical distribution of the different parts.*
*3rd. The gorge below the falls.*

1. *Detailed observations on the composition of the drift in the vicinity of the Falls of St. Anthony.*

*Section* 1. *At the Falls of St. Anthony, near the river.*

The drift-bank has been considerably excavated near McAlester College on the east side of the river for use in the repairs on the Falls by the United States Engineers. As the point of excavation

changes, thus successively revealing different parts of the bank, the nature of the whole may be ascertained. A common general section is as follows:

| | | |
|---|---|---|
| No. 1. | Loam | 3 ft. to 6 ft. |
| No. 2. | Stones and boulders, rounded, sometimes with a considerable thickness of sand | 5 ft. to 15 ft. |
| No. 3. | Red hardpan clay, with stones and boulders, lying on the rock | 10 ft. to 20 ft. |

In a few places along this excavation the color of No. 3, is not so distinctly red or copper-colored. It seems to be lighter, as if it had been mingled with hardpan of a later date which in much of the county is seen to overlie the red hardpan. This shading of color pertains only to the upper portion of the deposit. There are also places along the same bank where the light-colored or gray hardpan was deposited in considerable quantities, and still remains, and as the bank recedes a little from the river this light-colored hardpan occupies the inner and lower portion of the main slope in such a way as to hide the red entirely, and give a false impression of its having replaced it. In other places it is seen to lie directly on the red.

By further and more detailed examination of the same bank the foregoing No. 2 is seen to become separated into two or three pretty constant parts. It is sometimes clayey, and of a gray color. It is sometimes entirely made up of gravel and sand with belts of boulders, the alternation of parts being in general expressed by the following:

*Section* 2. *Detailed Section at the Falls of St. Anthony, near the river.*

| | | |
|---|---|---|
| 1. | Loam | 3 to 6 feet. |
| 2. | 2 (a). The gray sand and gravel | 0 to 10 feet. |
| | 2 (b). The gray stones and boulders | 1 to 10 feet. |
| | 2. The gray hardpan | 0 to 6 feet |
| 3. | 3 (a). The red sand and gravel | 0 to 10 feet. |
| | 3 (b). The red stones and boulders | 1 to 2 feet. |
| | 3. The red hardpan | 10 to 25 feet. |

There are three main parts or members. No. 1 is never wanting. No. 2 is always seen as far as this excavation is concerned, but its subordinate parts are not always all present. Very often 2 (a) and 2 (b) are the only portions seen; and in other places 2

(a) is wanting, the only thing that separates No. 1 from No. 3 being No. 2 (b). Of No. 3, the red sand and gravel may be absent, but in no case has the line of red stones and boulders been found wanting. The red hardpan, No. 3, is the most conspicuous portion of the whole, and is always present, rising sometimes by alternations with No. 2, (gray hardpan to near the top of the bluff.) There is in that case always a loam (No. 1) overlying, and a similar mixture of red stones and boulders with gray, immediately overlying the red hardpan. The gray hardpan at this point is quite unimportant as a member of the bank, but it is found to embrace very large boulders, not only of granite, but also of the Lower Trenton formation. Its color is very marked in contrast with the red hardpan. The stones in it have the appearance of glaciation. The *red hardpan at this place has not been seen to embrace a piece of the Lower Trenton.* Its boulders are usually small, rarely exceeding ten inches in diameter, while the bulk of it has only stones, less than four inches in diameter, and of a red color and quartzitic composition. "Greenstone" as a boulder is also common in the red hardpan. The iron in it, which causes the color, is *peroxide, non-hydrated.* The iron in the gray hardpan is *hydrated.*

The drift surface on the bluffs along the northeast side of the river, at Minneapolis, shows no gray hardpan. The bluffs rise about one hundred feet, average, higher than the top of the foregoing section and consist, so far as seen, of red clay and gravel. Toward the southeast, where the St. Paul and Pacific R. R. passes out of the valley of the Mississippi, the characters of the gray and red are mingled at first in an overlying stratum of gravel and sand, but before reaching St Paul the gray has entirely disappeared so that in the bluffs at that place the drift is all red clay, or sand, gravel and boulders derived from red clay, the whole having a characteristic prevailing red color. There are places where the shales of the Trenton have stained the drift clay at St. Paul, but those are low in the valley and near the river. The country generally at St. Paul and thence to Stillwater, on the St. Croix river, fifteen miles east, on the Wisconsin boundary, is everywhere covered only with the red drift. This statement is made without regard to the loam which is found very generally over this portion of the state. Within the valley of the Mississippi at St. Paul the upper portion of the drift is affected by the mingling of gray and red. The following observations, made in St. Paul, belong to this general class of facts.

*Section 3. On Sibley street, in St. Paul.*

| | | |
|---|---|---|
| No. 1. | Loam | 2 feet. |
| No. 2. | Stones and gravel, mostly limestone, also boulders, large stones, sloping to the SE. and E | 12 feet. |
| No. 3. | Sand and gravel in beds irregularly alternating with No. 2. Some beds of gravel are two feet thick | 10 feet. |
| No. 4. | Stones and gravel. In this are some northern boulders and limestone pieces, also pieces of green shale; the large stones sloping E. and SE | 20 feet. |
| No. 5. | Red sand, horizontally and somewhat obliquely stratified, often fine and clayey | 8 feet. |
| No. 6. | Red hardpan, seen | 12 feet. |

No. 6 above is often of the color of common red brick, and is very hard and compact. The stones in it are apt to be small. The upper portion at least shows in some instances a kind of lamination which still holds stones and is very sandy. In other places it passes into No. 5 gradually. But there is a very sudden and marked transition from No. 4 to No. 5, showing plainly a distinct deposit and a different origin. The iron in No. 4, and all above is hydrated, giving the whole a yellowish-gray, or olive cast, but although No. 5 consists of sand, and will admit water as freely as No. 4, it has only the red color of non-hydrated peroxide of iron. Hence the cause given for the color of the iron and of the drift (and generally accepted) as in Ohio, in contrasting the upper and lower portions, is not applicable here. Nos. 2, 3 and 4 make substantially one great deposit, and may come from the disintegration, under glacial water, of the usual clayey drift-sheet in the act of deposition—as the whole locality is in a low spot in St. Paul where the Trenton is broken down by some great drainage force. The boulders and stones in No. 6 are generally of metamorphic rock, there being but very rarely a piece of limestone. What pieces there are of limestone are of some foreign formation not evidently of the Lower Trenton. The stones in No. 4 are nine-tenths of them from the Lower Trenton.

Descending from Sibley street toward Wacouta street, and so toward the general centre of the tributary valley in which these excavations are made, Nos. 2, 3 and 4 gradually taper out and become no thicker than three feet, and other deposits replace them uncomformably thus.

*Section 4, between Wacouta and Sibley streets, St. Paul.*

| | | |
|---|---|---|
| No. 1. | Loam........................................ | 2 to 4 feet. |
| No. 2. | Horizontally stratified yellow clay, varying to blue near the bottom, with no stones nor gravel...... | 2 to 6 feet. |
| No. 3. | The same as Nos. 2, 3 and 4 of the last section, diminishing in thickness from 25 feet to 2 feet where it runs under the above No. 2, towards the lower portion of the valley........................ | 25 ft. to 2 feet. |
| No. 4. | The same as No. 5 of the last section, red and clayey, showing oblique stratification along the right of the cut, but horizontal along the left; at the extreme right hand passing downward into No. 5—the red hardpan........................ | 10 feet. |
| No. 5. | Stony, red hardpan, seen........................ | 5 feet. |

No. 2 becomes, at the crossing of Wacouta street, about 16 feet thick, and continues horizontally bedded, but with a gentle, general slope toward the N. E. or toward the centre of the valley. Its lower portion also changes to a quicksand. The gravel and sand of No. 3, of the last section, lie sometimes on No. 5 without the intervention of No. 4. The limestone masses, as well as the granite boulders in No. 3 have their angles rounded and decomposed, some masses even falling to pieces in the process of digging, though this is of course due largely to the quality of the rock. They are all water-worn and stained, rather than glaciated. The limestone masses are generally changed in color through and through, as if having been water-soaked in contact with air, or alternately in contact with air and water, for a great many years. They are not blue and fresh as water-soaked specimens are from a quarry, nor so well preserved as masses seen along the gorge below the Falls of St. Anthony. There are spots below Wacouta street where this member (No. 3) becomes clayey, making a gray stony hardpan, resembling that which covers the western part of Hennepin county, but still very gravelly and stony. This character does not rise above the lowermost two feet, so far as seen in the excavations on Wacouta and Sibley streets. Below Wacouta street the thick clay (No. 2 of the last section) is seen lying *below* a layer of stones and gravel, and this position can be traced in the opposite bank to some distance above Wacouta street, the clay gradually becoming thinner till it allows the overlying gravel and stones to come into contact with those of No. 3, the only remaining difference between the upper and lower parts being then a dif-

ference in *throw*, or slope, of the larger stones, as noted in *Section* 3. It is supposed to be the equivalent of the brick-clay at Minneapolis, at Lake Minnetonka and at Carver, though it does not everywhere make brick of the same color. It lies directly on the gravel and stones of No. 3, with a sudden transition, indicating some great and sudden change in the force depositing the material, followed again by a revival of the former drainage force, giving origin to the overlying course of stones and gravel. It is wholly embraced within the period of deposit of the gray or later drift.

The exposures within the Mississippi valley at St. Paul may be summarized in a general way as follows:

*Section No. 5. Summarized section of the drift within the valley at St. Paul.*

| | | |
|---|---|---|
| 1. | Loam | 3 to 10 feet. |
| 2. | 2 (a). Gray sand, gravel and stones | 0 to 10 feet. |
| | 2 (b). Fine, laminated blue brick-clay | 0 to 16 feet. |
| | 2 (c). Gray sand, gravel and stones | 20 feet. |
| | 2. Gray hardpan | 2 feet. |
| 3. | 3 (a). Fine, laminated red sand or clay, the *Tripoli* of Stillwater | 0 to 10 feet. |
| | 3 (b). Red hardpan | 10 to 20 feet. |

Outside of the valley of the Mississippi near St. Paul, and within the limits of the city, the general aspect of the drift is red, particularly toward the east, the red hardpan, or its product, the red sand and gravel, rising to the tops of the bluffs, the foregoing No. 2, of the general section, being absent. The red hardpan is sometimes locally modified, and is largely converted by wash and drainage to a coarse sand, as seen in the cuts near the St. Paul and Pacific Junction with the West Wisconsin Railroad. Along the north bluffs of the river this character prevails, overlain by a thickness, usually not great, of No. 1.

At three-quarters of a mile below the University the drift at the rim bank consists as follows:

*Section 6. Three-quarters of a mile below the University.*

| | | |
|---|---|---|
| 1. | Loam | 5 feet. |
| 2. | Gravel and gravelly clay | 20 feet. |
| 3. | Red hardpan to the rock, perhaps | 15 feet. |

At Minneapolis, near the west end of the lower bridge, the drift

consists apparently of gray hardpan, 7 feet, without any trace of the older red drift. The same is true at the stone quarries about a quarter of a mile further S. E.—thus in more detail at the quarries.

*Section 7. At Bank's Arenson's quarry, Minneapolis.*

| | | |
|---|---|---|
| 1. | Loam | 3 feet. |
| 2. | Gravel and stones, the latter being mostly granitic, but with a few pieces of limestone, varying to | 12 feet. |
| 3. | Stony, gray hardpan clay | |

*Section 8. Corner of Washington avenue and Sixth avenue, north, Minneapolis.*

| | | |
|---|---|---|
| 1. | Loam, stratification not evident; apparently passing downward into brick-clay | 2 to 4 feet. |
| 2. | Brick-clay | 1 to 4 feet. |
| 3. | Fine sand, lying unconformably under the last | 1 to 4 feet. |

No. 1 contains calcareous concretions as large as peas and walnuts. It cannot be said to merge certainly into No. 2, but it seems to. The stratification of No. 2 fades out gradually upward, while the texture and composition continue somewhat into No. 1, becoming also yellow, or at last rich brown or black when it is termed soil. No. 2, as seen in this exposure, consists of a long synclinal, the axis running nearly north and south, toward the west, so lifted as to disclose what it lies on, (No. 3.) It is quite calcareous, showing concretionary lumps, and coatings, and also at a point on Fifth street, fresh water species of shells—though the cut there may be more nearly the equivalent of No. 1. This section shows that the source of the water which spread the brick clay was toward the west, and that the bottom on which it was spread was one of stratified fine sand which increased toward the west. This is near the descent to Bassett's creek, and over the St. Peter sandstone, (the Trenton having been broken down,) and that stream or its valley, had something to do, probably, with the sudden transition seen here from sand to brick clay. Although there is at one point in this cut an agreement in direction between the strata of the sand and those of the clay, yet on close inspection it appears that the clay came on suddenly.

At the yard of the *Union Brick Company* (Baxter, Woodward and M'Nair) the clay is yellow, with some beds of fine white sand to the depth of about eight feet, when it begins to show blue.

Upward here it becomes a clayey loam. The strata have a wavy outline, synclinals and anticlinals following each other twice in about 14 rods, rising and falling six feet.

At Woodbury's brickyard, which is about half a mile west of the Union Brick Company's, within the valley of Bassett's creek, the clay is underlain by a quicksand which furnishes water that rises to within twelve feet of the surface. The clay is about forty feet in thickness and contains thin layers of sand, interlaminated, which becomes white on drying. The upper portion gradually becomes yellowish by exposure and the hydration of the iron, the lower portion being blue. There are also in it calcareous concretions and a few large *Unio* shells which are very fragile. This clay seems to occupy the valley of Bassett's creek generally. At the Sumner School house, which is in the valley of this creek, north of Woodbury's yard, after drilling through this clay, over 100 feet, an artesian overflow of water was obtained.

Passing across Bassett's creek, on Western avenue, and ascending the bluffs on the west side of the creek, the drift is found to consist of the red gravelly hardpan, covered by a light loamy soil. The surface is rolling, with frequent springs and numerous lakes.

At Richfield P. O., Minnehaha creek runs about 35 feet below the general level of the country, and the banks are composed of gravelly, gray or yellow clay. No red clay can be seen. But at the school house in Richfield, Sec. 18, on Minnehaha creek, the well, dug, disclosed the red drift clay some feet below the surface. At the Edina Mills there is a bank of drift, composed of clay and gravel of the usual gray color, containing many pieces of the Trenton limestone.

On the NW. ¼ of Sec. 8 (S.) Crystal Lake, a cut in the Osseo road shows the gray and red hardpan as follows:

*Section* 9. *NW.* ¼ *Sec.* 8 (*S.*) *Crystal Lake.*

| | | |
|---|---|---|
| 1. | Gray or yellowish hardpan, with few Cretaceous pieces, and some boulders | 8 feet. |
| 2. | Red hardpan passing into red sand and gravel below | 6 feet. |

The red passes into the yellow by a series of blotches interchanging one with the other, as if coarsely mixed. Even between the blotches there is a sudden change of color. When the line of union is not broken up into blotches the change of color is abrupt. The late, or gray hardpan is more calcareous than the older. The appearance of the red drift is, as if there had been a lake, or at least a low spot in it, prior to the deposition of the gray.

In Sec. 16, Eden Prairie, a cut by the road shows the red drift, on a low level, but five or six feet above the creek, while in the higher portions the gray only is seen.

Near the mill at Minnetonka City the old red drift can be seen in a little excavation by the road, on a level with and near the creek. It is overlain by a course of stones and gravel, in which appears a piece of the Trenton, and that again by the great deposit of the gray hardpan generally over the country.

The drift knolls at Wayzata are of the brown hardpan, but occasionally show the red at low levels where cut by the roads.

About the west end of Lake Minnetonka the drift is very clayey and has a great proportion of Cretaceous materials. The water of wells is very hard.

The ridge which enters the corporate limits of Minneapolis (Sec. 27) is a spur from the main drift-bluff running along the west side of the river. The most of it, within the limits of the city, is of gray hardpan and gravel, with variations toward the west and northwest toward the red hardpan, of which there is a considerable area extending to and beyond Cedar Lake.

Sec. 36, Champlin. The rolling land begins gradually, the timber changing also gradually. The rolling land is stony, clayey or gravelly, with patches of sand as revealed in wells, and some places of stratified clays near the flat country. The stones are mostly granitic, but have among them, also, numerous large masses of light-colored, fine-grained dolomite, which are burned for quick-lime. The ridges are said to run generally S. W. and N. E., but are very irregular, with depressions and cross-ridges. Water is easily got in wells at about 40 feet—sometimes in 15 or 20.

At the mouth of Elm creek, near Champlin, the bank is exposed by a recent wash, disclosing the composition of the plain on which are Osseo and Brooklyn. The upper portion of the bank, including the loam, is 18 feet, and consists of coarse sand, with gravel and pebbles obliquely stratified, the whole of a light brown color. The lower portion—25 feet—consists of red hardpan which continues down to the level of the water of the Mississippi.

In traveling the river road from Champlin to Dayton, a very noticeable change occurs in the nature of the surface drift, before reaching the latter place. It becomes lighter colored, shaly or ashy, with pieces of slate. About a mile below Dayton a large freshet wash by the roadside, where a creek enters the Mississippi river, shows an exposure of about 35 feet of pebbly clay of a light, gray color, with pieces of slate, and an occasional boulder near the bottom, underlain by a sand of the same color, 20 feet thick,

varying to very fine or clayey, stratified, which, washing out easily, causes the downthrow of large masses of the clay, both in the creek gorge and along the river bluff. No red drift is visible. The surface about is rolling, with occasional boulders.

At Dayton the general character of the surface is of the gray, or ashen, slaty, rolling hardpan. Along the bank of Crow river the drift is exposed in a good section.

*Section* 10. *At Dayton.*

| | | |
|---|---|---|
| 1. | Stratified fine sand and clay............................ | 10 feet. |
| 2. | Blue drift hardpan.................................... | 25 to 30 feet. |
| 3. | Red drift hardpan...................................... | 8 to 10 feet. |

In No. 2 are many fragments of Cretaceous slate, sidorite, iron concretions, (covered with gravel and cemented by iron rust,) granitic pebbles, and (Devonian ?) limestone masses which have supplied a great deal of quick-lime, and an occasional large granite boulder. In No. 3 are a great many small greenstone and quartzite stones, and but few that are large, also many granitic stones. Along the bank of the river a piece of native copper about the size of a hickory-nut was found by James Ream.

At the old bridge on Sec. 18, Hassan, or a few rods below it, on the right bank of Crow river, is a deposit of coarse crag, three feet thick, comprising the pebbles and stones that were washed out of the old red hardpan. It dips a little to the east, and shows as a persistent layer for 30 or 40 rods, causing a terrace in the surface of the alluvium of the flood plain, and rising, at the bridge, about 18 feet above the river, beyond which it seems to strike inland and is lost. It also appears on the opposite side of the river above the bridge. In the opposite direction it finally runs down to the level of the river, eastward, and disappears. It has been used by Mr. Hoag for underpinning for his house.

About the lakes (Mother, Amelia, Calhoun, &c.,) the country is rolling, but is less so toward the southeast part of that tract; indeed the rolling area gradually dies away into the plain in some parts of Richfield so that its eastern margin is not so marked. On the plain the soil and the subsoil is gravelly or sandy, very rarely stony. The same is true of the rolling tract about Diamond Lake. There are no stones in the fields nor about the lake shores. This seems to indicate the agency of water rather than of ice in piling up these outer knolls, and in spreading the gravel of the plain. Minnehaha creek has a gravelly bottom all the way below Richfield, at least.

Through sections 20 and 19, in the southern part of Bloomington, the hardpan drift, on the north side of the Ferry road, rises above the flat on which the road runs, with the appearance of a terrace, and is wooded with oaks, aspens and ironwood. For some distance the terrace-like level on the surface of the hardpan is about half a mile north of the road, and rises about 40 or 50 feet. It is stony with occasional boulders, becoming more rolling further north.

At Bloomington Ferry the river runs near to the hardpan bank on the north side. The bank rises 140 feet above the water in summer. This is about the average, the top of the hardpan being of irregular outline. This includes the "terrace" of hardpan mentioned in sections 20 and 19. That terrace appears to approach the river here. The surface farther back is still higher, and indeed continues to ascend with an irregular contour. The hardpan is yellowish brown or gray, and gravelly near the top, but also has afforded some large granite boulders, that now lie in the street near the ferry, and others that are on the beach below the ferry. The Minneapolis and Chaska brick-clay is seen also at the ferry, and some years ago supplied a red brick seen in the house of Mr. Chadwick. Within a mile and a half, toward Eden Prairie, the surface rises apparently about 100 feet higher.

The well of Mr. J. Miller, N. W. ¼ sec. 9, Crystal Lake, was dug March, 1875, by Mr. J. G. Sommers, who gives the following section:

*Section* 11. *N. W. ¼ Sec.* 9, *Crystal Lake.*

| | | |
|---|---|---|
| 1. | Loam | 1 foot. |
| 2. | Yellow hardpan, with little stones | 5 to 6 feet. |
| 3. | "Blue black clay" with no stones nor bedding; "one solid mass." This had sticks at different depths, and small pieces of Cretaceous coal, but positively no stones. Small quantities of water were met at 15 feet below the surface, and again at 25 feet | 45 feet. |
| 4. | Sand, boulders and gravel, all mixed; clean, with no clay. Some of the boulders being very large | 3 feet. |
| 5. | Light clay (even lighter than No. 2) with small stones but no boulders; nothing red about it | 19 feet. |
| 6. | Mixed stones and gravel; cemented | 1 foot. |
| 7. | Sand with water | 2 feet. |
| 8. | Blue limerock; rough, not polished nor scratched; depth of well | 76 feet. |

At Charles Grotjann's old brickyard, in Upper St. Anthony, the clay contains lumps and concretions of clay, and also the usual limy concretions. The most interesting feature at this point is the jamming and folding to which this otherwise regularly laminated brick-clay has been subjected. There is a thrust-up place near the river, at the brickyard, which shows these laminations crumpled and broken, with a sudden transition upward into gravel and sand, which is unconformably stratified. This might possibly have been done by floating ice in the river at some earlier stage of the valley when the river may have covered this level which is 15 or 18 feet higher than the usual freshet rise of the water. Yet it hardly seems attributable to that cause, since it is not only covered with the loam, which is referable to that last high stage, in undisturbed continuity, but is so deeply within the bank that crowding ice could hardly reach it. The terrace flat of Upper St. Anthony, underlain by the brick-clay, is 25 feet higher than the river.

The highest drift knolls in the neighborhood of Minneapolis are in Anoka county, about Sec. 24 Manomin, in the neighborhood of Sullivan's and Moore's lakes, but east of them. They are of red drift clay, with gravel and granitic boulders, yet *the boulders are not so common* as might be expected from the fact that these areas suffered the exposure and surface drainage incident to the last glacial epoch. The soil is clayey, and loamy, but between the bluffs and the river are extensive sandy flats. Little wet spots, even lakes and swales which never become dry, lie between these knolls. These hills continue SE. toward Bower's Lake in Ramsey county. The high hill north of and near Bower's Lake is 130 feet higher than the NE. corner of Moulton's Nursery, which may be taken as an average height for the hardpan drift bluffs along the east side of the river. From the Nursery to the foundation of the University is a further descent of 110 feet; thence to the river at the University 137 feet, making a total descent from the high knolls at Bower's to the river below the falls, in the rapids near the University, of 377 feet.

On section 12, Crystal Lake, near the mouth of Shingle creek, in digging a well for Mr. J. Kesler, Mr. O. E. Spear found a stick as large as his wrist in a blue clay, (the brick-clay) that had no stones nor gravel, about 18 feet beneath the surface.

On the N. E. ¼ sec. 12, Crystal Lake, at Peterson and Swansen's brickyard, this same clay is manufactured into cream colored brick. It is obtained in the immediate river-bank, and runs appa-

rectly beneath the river. It is blue, stoneless and horizontally stratified.

*Section 13. N. E. ¼ Sec. 12, Crystal Lake, at Peterson and Swensen's Brickyard.*

| | | |
|---|---|---|
| 1. | Loam | 3 feet. |
| 2. | Sand, gravel and pebbles; stratified; sometimes rusty | 4 to 6 feet. |
| 3. | Brick-clay; blue; horizontally bedded | 15 feet. |
| 4. | Slope to the river; apparently clay | 15 feet. |

An ideal section of the right bank of the river at this place, (near the mouth of Shingle creek,) would be as shown by the following diagram. This is based on the observed exposures of the various parts in such topographical positions as indicate its correctness :

The above figure represents the brick-clay as lying immediately on the St. Peter sandstone, because at that point no drift-clay can be seen to lie between them. It is more probable, however, that a deposit of drift-clay, perhaps both the red and the gray, runs below the brick-clay, as seen at St. Paul ; or at least that such a deposit ante-dated the brick-clay, though sudsequently perhaps entirely swept away.

Further information concerning the drift was sought for in developments of the common wells throughout the country. The following table shows the result :

## *Wells in Hennepin County.*

| Owner's Name. | Location. | Feet in the drift. | Feet in the rock. | Total Depth. | Remarks. |
|---|---|---|---|---|---|
| N. O. Phillips | NW. ¼ Sec. 6, St. Anthony | 90 | .. | 90 | Water comes from the clay; fails in dry season. |
| D. D. Moore | SE. ¼ Sec. 6, St. Anthony | 40 | .. | 40 | Clay nearly 40 feet; then coarse sand; little water. |
| D. D. Moore | " " | 40 | .. | 40 | No water. |
| Frank Thery | " " | 87½ | .. | 87½ | "Blue clay" 24 feet; then red clay sand and gravel; good water. |
| —— Wilson | Hoyt's Addition to St. Anthony | 15 | .. | 15 | All sand; then struck the rock, which is smooth like a floor. |
| Crystal Lake House | Sec. 10, Crystal Lake | 20 | .. | 60 | No rock; good water; near the river. |
| Jesse N. Richardson | Richfield P. O. | 69 | .. | 69 | Gravel and gravelly clay; good water. |
| —— Rankin | Eden Prairie Station | 43 | .. | 43 | Sand and coarse sand; good water. |
| John Brown | Near Bloomington Ferry | 98 | .. | 98 | Clay and sand; good water. |
| John Scofield | Four or five miles E. of Bloomington Ferry | 62 | .. | 62 | Good water. |
| —— Marville |  | 75 | .. | 75 | Clay and hardpan 60 feet; sand and clay alternating. |
| —— Clark | ¼ mile N. of Highland Park | 59 | 10 | 69 | Clay and sand; drilled in lime rock. |
| N. Palmer | Gale's 2nd Addition, Minneapolis | 26 | 19 | 45 | 26 feet boulders and clay; then in limerock |
| Fred Wagner | No. 1200 N. 23rd St., Minneapolis | 25 | 19 | 44 |  |
| —— Balliff | 4 miles E. of Bloomington Ferry | 50 | .. | 50 | First 25 feet all sand. |
| Wm. Knight | SE. ¼ Sec. 10 Crystal Lake | 14 | .. | 14 | Sandy loam; good water. |
| C. H. Sanborn | NW. ¼ Sec. 5, Crystal Lake | 40 | .. | 40 | Good water. |
| All wells in | Osseo, and Brooklyn generally | 12–14 | .. | 12–14 | Flat country; good water. |
| Wm. Schmidt | Sec. 36, Champlin | 45 | .. | 45 | Sandy knoll. |
| Mathias Zopli | Sec. 36, Champlin | 20 | .. | 20 | Ten feet of good water. |
| Ferdinand Schmidt | Sec. 1, Maple Grove | 44 | .. | 44 | Twelve feet stratified clay and sand; good water. |
| Fonduck House | Champlin | 33 | .. | 33 | Got water at 8 feet above a "dark clay" (red clay ?) |
| Wells at | Champlin, generally | 95–93 | .. | 95–93 | Good water. |
| —— DePuy | Sec. 12, Hassan | 17 | .. | 17 | All clay; seeps. |
| Peter Hill | SW. ¼ Sec. 4, Minneapolis | 22 | .. | 22 | Gravel and sand; near a tamarack swamp. |
| David Corban | NE. ¼ Sec. 12 | 70 | .. | 70 | Nearly all clay; water in sand; rose 25 feet. |
| Joseph Hennesey | SW. ¼ Sec. 29, Maple Grove | 16 | .. | 16 | In clay. |
| Thomas Hennesey | " " | 15 | .. | 15 | In clay. |
| Martin Devery | SW. ¼ Sec. 28, Maple Grove | 65 | .. | 65 | Blue clay; water in sand. |
| Wells generally at | Maple Grove | 15–25 | .. | 15–25 | In blue clay; no knowledge of any red clay. |
| Crystal Lake House | SE. ¼ Sec. 6, Crystal Lake | 40 | .. | 40 | Sand nearly all the way; then clay. |

## *Wells in Hennepin County.*—Continued.

| Owner's Name. | Location. | Feet in the drift. | Feet in the rock. | Total Depth. | Remarks. |
|---|---|---|---|---|---|
| Frank Paul | SW. ¼ Sec. 31, Richfield (E) | 75 | .. | 75 | 40 feet loam; the rest clay; no rock; no water. |
| Frank Paul | " " | 27 | .. | 27 | Sand all the way; no rock; no water. |
| Frank Paul | " " | 53 | .. | 53 | No rock, nor water. |
| Wm. Franchou | NW. ¼ Sec. 31, Richfield | 53 | 11 | 46 | 11 feet in lime rock; then white sand, and good water. |
| F. X. Brousseau | Sec. 14 Bloomington | 27 | .. | 27 | Sand; near the river bluff; water on clay. |
| J. Stansfield | NW. ¼ Sec. 14, Richfield | 56 | .. | 56 | Some clay, but mostly gravel; good water. |
| T. Vessey | Sec 5, Bloomington | 56 | .. | 56 | Near the river; in the bluffs. |
| E. M. Snow | Long Lake | 14 | .. | 14 | Mostly sand and gravel; then blue clay; good water. |
| May and Co | Long Lake | 60 | .. | 60 | Mostly hardpan; water "irony." |
| Medina Mills | Long Lake | 175 | .. | 175 | Gravel and sand; then blue clay; good, soft water. |
| D. E. Priest | Sec. 23, Minnetrista | 25 | .. | 25 | Yellow clay hardpan and sand; "hard" water. |
| Jacob Schleh | St. Bonifacius, Minnetrista | 36 | .. | 36 | 18 ft. yellow clay; 18 ft. blue clay hardpan and sand; good water in gravel. |
| J. Metz | " " | 36 | .. | 36 | " " " " |
| J. Miller | NW. ¼ Sec. 9, (S.) Crystal Lake | 56 | 20 | 76 | Loam, yellow clay and blue clay 56 feet; contained sticks; struck the limerock. |
| R. S. Lee | Highland Park, Minneapolis | 27 | .. | 27 | Clay, sand, clay, sand; good water. |
| Lambert Negley | 19th St., bet. 20th and 21st Aves., N | 45 | .. | 45 | Sand all the way to white sand rock |
| —— Halsey | 19th St., bet. 20th and 21st Aves., N | 37 | 8 | 45 | Eight feet of limerock. |
| John Eagle | Cor. 20th St., and 21st Ave., N | 20 | 25 | 45 | Limerock 15 feet; sandrock 10 feet. |
| —— Parker | Christmas Ave. and 23rd St. | 39 | 9 | 48 | Clay; struck rock at 39 feet. |
| John Hooper | NE. ¼ Sec. 8 (SE.) Crystal Lake | ? | .. | ? | Struck the limerock. |

## 2. *Geographical distribution of the different parts.*

### (a). *The red hardpan.*

This, which from its position must be regarded the oldest of the different parts, is found exclusively in the eastern part of the county, and thence eastwardly to St. Paul, and through Washington county to Stillwater. It seems to be the principal deposit, rising from immediate contact with the indurated rocks to the surface of the country. It is locally modified by the loss of its clay, so as to consist almost entirely of coarse sand and gravel, or, in other places, of stones and boulders. Along the main valleys, as at St. Paul and at Stillwater, its upper portion, to the thickness sometimes of twenty feet, consists of very fine clay, which yet seems to contain a large per cent. of silica, (nearly 75 per cent. according to Prof. Peckham,) the whole derived doubtless from the gentle washing of the red hardpan. This fine red clay has been referred to in a former report as possibly pertaining to the Cretaceous. Its color is due to non-hydrated ferric oxide. The red hardpan also appears on the west side of the river at the surface of the drift, and constituting its principal mass, in the western part of the township of Minneapolis, in the rolling tract that embraces lakes Calhoun and Cedar; also northwardly to Bassett's creek; also, with some modifications in much of the townships of Richfield, Eden Prairie and Minnetonka. As a loam covers much of this part of the county it is not possible to define the exact limit of its distribution. There is a rolling belt of small timber, (oaks and aspens,) that extends north and south across this part of the county, which seems nearly to coincide with the superficies of the old red drift clay on the west side of the river. In general that is the timber that characterizes it on the east side of the river. Even within this area on the west side of the river there are spots where the color of the hardpan is modified toward the gray color; and other places where there are important deposits of gray hardpan overlying the red. This is particularly the case in the northern part of Minneapolis, and in Crystal Lake townships, covering the locality at which the Mississippi seems to have been deflected from its old channel. The extensive flat in eastern Minneapolis, Richfield and Bloomington townships is also underlain by this red hardpan, but it is also supplied with extensive superimposed gravel deposits, as well as with patches of unmodified gray hardpan. The gray hardpan may be seen in the immediate bluffs of the river in some cases, both on the west and on the east sides, within the

limits of the city of Minneapolis, but the red is found to lie nearly everywhere, under this flat as the lowest portion of the drift. The red extends under the gray hardpan an unknown distance westward. It is seen in deep valleys and excavations along the central portions of the county, but with decreasing frequency toward the west and northwest, until nothing is known of it, at least within the limits of Hennepin county.

### (b) *The Gray Hardpan.*

This covers the greater part of the county, gradually becoming thinner toward the east and southeast. Within the valley of the Mississippi it extends at least to St. Paul, found in the depressions between the rock bluffs, or in the lower depressions in the old drift-surface. In those areas, however, not embraced within the river valley, nothing has been seen of the gray hardpan as far east as St. Paul. The gray hardpan, or the gravel, sand and stones that result from its modification, seems to be spread generally over the upper flats and terraces that exist, from different causes, along the river below the Falls of St. Anthony. It begins to be mingled with the red drift, and finally to cover it entirely, within the limits of Minneapolis. The conspicuous ridge of hardpan within the city, (sec. 27,) is of a gray color, but it blends with the main river bluffs toward the northwest, along the west side of Bassett's creek, and loses its distinctive characters. The gray color, however, prevails on the north and east side of the creek, through a rolling tract of country, and into Crystal Lake township—and thence, uninterruptedly, northwestwardly. The gray hardpan surface is specially characterized by heavy timber, particularly after passing out of the valley of the Mississippi, and thus beyond the area liable to its modified conditions. It is observable that the eastern line of the Big Woods, properly so-called, (i. e. comprising large trees of Sugar Maple, Bitternuts, Elm, Bass, Oaks, &c.,) nearly coincides with the eastern line of the unmodified gray hardpan, and approaches the Mississippi river at Champlin, actually reaching the river bluffs a few miles below Dayton. This line may be said to run, in general, from the eastern end of Lake Minnetonka to Champlin. Whatever gray hardpan is found to the east of that line, or to the southeast, speaking generally, seems to have been mingled with the red, and to have lost much of its clay. It is hence often converted to a gray gravel and sand, and is in many places replaced by red hardpan or by red gravel and sand. A gray gravel which varies to a hardpan, is spread out over the flat on which Minne-

apolis stands. This is covered by the loam, and is underlain by the red hardpan.

### (c) *The Brick-Clay.*

This is found particularly within the valley of Bassett's creek, and, above its mouth, in the valley of the Mississippi. It very rarely rises above the level of the top of the Trenton terrace, but has a thickness, as shown by the well sunk at the Sumner School house, of over 100 feet in some places. A similar clay, supposed to be of cotemporaneous origin, is seen embraced between deposits of gravel and boulders, at St. Paul, as shown by the general section at that place, and lying above the gray hardpan. A similar stratified clay is found at Lake Minnetonka, and at Carver, in the valley of the Minnesota.

The general distribution of these parts, in the vicinity of Minneapolis, is shown by the accompanying map, but a great many details, and exceptions are disregarded.

At Banks Arenson's quarry, on the west side of the river, nearly opposite the State University, the gray hardpan, which is stripped off the rock for quarrying, lies over a glaciated rock-surface, the marks running N. NW. and S. SE. While these marks correspond with the general direction of the river at this point, their regularity and persistence over a large surface preclude their having been caused by the action of the water of the river. The quarry has also been worked back from the line of the strike of the bluffs, and this stripping is about four rods back from the old line. The marks are also immediately overlain by a stony hardpan which is of the last glacial epoch, being olive-colored or earthy, not red like that which lies on the rock generally on the east side of the river.

Glacial striæ on Hennepin Island, above the paper-mill, run 32° West of North, by compass.

When the rock-surface was exposed for the City Market, it was not striated, but polished and scratched promiscuously.

The rock-surface is said to be glaciated on Nicollet Island, but no opportunity has been afforded of taking the direction.

According to Col. J. B. Clough, of Minneapolis, a piece of native copper weighing 70 pounds was taken from the drift in a R. R. cut, on the Minneapolis and St. Louis R. R., about 13 miles S. W. of Minneapolis, in 1872.

A piece weighing about two pounds was found in the fall of 1874, in grading the streets of Minneapolis.

Mr. W. D. Hurlbut has also found several pieces in the drift near Rochester, in Olmsted county.

### 3. *The Gorge below the Falls.*

From the Falls to Fort Snelling the gorge between the rock bluffs is about a quarter of a mile in width, and the rock has a freshly-broken appearance, the large fragments thrown down by the action of the water, as the falls receded, still existing in the talus along the bluffs. Throughout this distance (nine miles) the rocks lie horizontal, hence the recession, so far as it depends on that element, has been of uniform rate. The hight of the bluff above the river remains also nearly the same throughout this entire distance, increasing a little perhaps near Fort Snelling. The relative length of time during which the rocks of this gorge have been exposed to atmospheric forces, compared to that of the bluffs below Fort Snelling, or to that in the ancient valley now occupied by Bassett's creek, is indicated by the depth to which they have been weathered or stained. It is well known that the same rock may present different colors from the effect of atmos pheric agents. The Lower Trenton, for instance, is blue within, when freshly quarried at fresh exposures. That is the color it has in all the quarries below the falls at Minneapolis, and which it shows in deep quarrying at St. Paul. This color is met with either immediately at the surface, as at the Falls, or within an inch or two of the surface as at Fort Snelling. When weathered long, the stained coating becomes thickened. The stone then is either rusty-buff, or yellowish and dirty, resulting from the oxydation and hydration of the iron which it contains. This color may penetrate to the depth of several feet, depending on the porosity of the rock, and the length of exposure. At quarries above the falls of St. Anthony, near the mouth of Bassett's creek, this stained condition is found to penetrate the whole Lower Trenton, the rock at the same time having become more easily separable along some of its bedding planes, and also more firmly cemented by the permeation of the iron through the more shaly parts. The same change is visible in the old river bluffs above the falls where the Lower Trenton is wrought on the east side of the Mississippi, opposite the mouth of Shingle creek, and to a considerable extent in the quarries in Upper St. Anthony.

The gorge below Fort Snelling, where the Minnesota and the Mississippi unite, is about a mile wide, between the rock-bluffs; and the Minnesota above Fort Snelling has the same width between

the rock-bluffs. Besides the aspect of greater age, as indicated by the greater change of color in the rock below Fort Snelling, the bluffs themselves are smoothed and the rock hid by drift and loam since the action of the river ceased. The top of the rock along the gorge above the fort is surmounted with a thickness of drift gravel and clay, which shows a section, as cut by the river, continuous, perpendicularly, with the rock-bluff itself. This thickness of drift is nearly uniform from the Fort to the Falls, and indicates the spreading of the drift before the recession of the Falls; but below Fort Snelling (with a single exception, to be noted,) the rock-bluff is generally hid by a subsequent accumulation of drift. The same is true of the bluffs of the Minnesota above the Fort. This subsequent accumulation is so abundant above the Fort along the Minnesota, that the strike of the Trenton limestone is totally hid within less than a mile.

The direction of the Mississippi changes at Fort Snelling, making a right angle, from S. E. to N. E., but the change is caused by its entering the wide gorge which runs in that direction. The wide valley in which the Minnesota runs is out of proportion with the amount of water which it carries, but its valley continues of the same width, and in the same direction beyond the confluence of the Mississippi, the valley taking the latter name.

Below Fort Snelling, opposite the mouth of the Minnesota, is a low, long, alluvial island, (Pike Island,) running to a point downstream. The existence of this island, which lies in the wide gorge, and which must have been formed since the excavation of the gorge, points directly to some force not now existing; since the joint action of the two streams uniting, instead of accumulation, would be the reverse under normal conditions. If the volume of the two rivers were to be increased so as to have sufficient momentum to move the substructure of Pike Island, the result would be the gradual destruction and removal of the island, instead of its increase. The retardation of the current causes it to drop sediment, but when two streams unite, the current is not retarded, but generally by reason of closer confinement in a proportionately narrower channel, it is increased.

The right bank of the Mississippi, just below the confluence of the two streams, shows, for about half a mile, a fresh erosion of the rock-bluff similar to that of the bluffs above the fort, the current of the river having been driven against that bank so as to undermine the limerock and cause its downfall. This is opposite the point at which the Mississippi enters the wide gorge. Pike

Island lies alongside of it, and between it and the debouchure of the Mississippi into the wide gorge.

Above the mouth of Bassett's creek the Mississippi runs between rock-bluffs of the same kind as those below Fort Snelling. They are about a mile apart and show all the above named indications of greater age. They, however, rise but about thirty or forty feet above the river, and are buried under the loam, or under the drift and loam. This old valley continues southwardly by way of Bassett's creek, and its course, as supposed, is expressed on the accompanying map of the region, drawn on a scale of one inch to one mile. This old valley was cut down into the St. Peter sandstone over one hundred feet, since it has been drilled into at the Sumner Schoolhouse in Minneapolis without striking rock, to even a greater depth than that.

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From the foregoing facts the following interesting history may be read. It is believed that the glacial theory of L. Agassiz, and nothing but that, will explain the grand changes which this history relates.

Prior to the last glacial epoch the Mississippi river did not run over the Trenton limerock at all, but passed, in a wide, deep valley, similar to that which it now occupies below Fort Snelling, by way of the valley of Bassett's creek, and lakes Calhoun, Harriet and others, along the western side of the Trenton area, and joined the Minnesota at some point above Fort Snelling, but probably between Shakopee and Fort Snelling. The country was then covered with the drift of an older glacial epoch, and was probably timbered with species of trees the same as those now living.

As the last glacial epoch approached, the transport of drift material was from the northwest. After the closing of the northward outlet of the Winnipeg waters by the accumulated ice and the perpetual winter, they were drained southwardly through the valley of Big Stone lake and Lake Traverse, into the Minnesota valley, and thence into the Mississippi, past the site of Fort Snelling. Their volume was augmented not only by the proper volume of the Minnesota itself, but by the dissolution of the ice of the glacier that gradually crept over the state from the north, and northwest, as it arrived in latitudes too genial for the existence of ice.

The land ice not only disrupted the old drift surface and distributed its material as it moved on, but also gathered a great deal of

the bed-rock itself, particularly of the Cretaceous. This Cretaceous debris, being abundant and easily transported, gave its own shaly color to the drift with which it was mingled, and even stamped on the clay of this drift period a peculiar and characteristic quality, thus rendering it easily distinguishable from the older drift which was of a red color and charged with small red or green stones, with few granite boulders. The later drift contains more numerous large granite boulders than the older. Round the southern limit of the land ice, the old red drift was thrown up into hills and ridges and shoved into old valleys, and locally mixed with, or covered by, the gray drift of the later period.

In the valleys, particularly those having a southward drainage, the gray drift was transported most freely and distributed most widely, partly by the agency of the abundant water. The Minnesota was much larger than the Mississippi, and the Mississippi was much larger than it is now. Large quantities of floating ice would also pass down these streams, carrying from the glacier, stones and gravel, distributing them on the then flood-plains, the now gravelly terraces of the Mississippi.

The margin of the ice did not extend across the Minnesota into Dakota county.—At least it did not obstruct the Minnesota river so as to permanently divert it from its course, and certainly did not reach far south of that river, since the isolated outliers of the St. Peter, (as Castle Rock,) round whose bases the older drift lies, were not destroyed. The ice choked up the old valley of the Mississippi below the mouth of Bassett's creek, and filled it with drift clay, the river itself being, at the acme of the cold, reduced to smaller dimensions by the contraction of the field drained, and by the changed topography of the country toward the north. The river was thus forced to pass round the eastern foot of the ice further to the southeast, a lake of standing water perhaps covering the valley which it had abandoned, and setting back into a portion of the valley still occupied. This water, fresh from the glacier, was very muddy, and gave origin to the brick-clay that lies in its old valley, as shown by the accompanying map showing the surface geology.

The Mississippi, thus forced out of its old channel, after rising to the level of the limerock of the Lower Trenton, ran *over* the rock, to reach the same valley again by plunging over the precipice at Fort Snelling, thus giving birth to the Falls of St. Anthony. In reaching that point it had crowded on to the old drift bluffs along the east side of the river, driving them, by erosion, further toward

the east, while the old valley itself served to retard, and even to limit, the transportation of the drift clay toward the east.

Later, as the volume of the river increased by the dissolution of the ice and the opening of the tributary valleys as it withdrew, the waters spread over the whole area from the line of the old drift bluffs on the east, to the recently made moraines along its west banks, receiving and distributing not only gravel and sand over the whole broad valley, as at Minneapolis, but also large quantities of the gray hardpan clay.

It was at this time that Pike Island began to form; and also that the current of the Minnesota was carried, by the added momentum of the Mississippi, against the opposite bluffs below Mankato, so as to produce new exposures of the sand and limerock.

The Falls must have begun at Fort Snelling near the acme of the cold, as the effect of the ice is not important at any points south or east of the mouth of Bassett's creek. They have occupied the interval of time elapsed since then in receding to their present position. Were it possible to establish a unit of recession for a calculation, the length of that interval could be computed. The rate has been much greater since the construction of dams and mills, diverting the water, or concentrating it at points; and hence the data of recession since the permanent occupancy of the region, are valueless for this purpose. The only other means of estimating the rate of natural recession is to employ the statements of the early travelers who have described the Falls. Their discoverer was Father Louis Hennepin. In returning from his captivity among the Dakotas, he saw the Falls in July, 1680, and briefly describes them as follows: "This fall is forty or fifty feet high, divided in the middle by a rocky island of pyramidal form."

"In ascending this river ten or twelve leagues, navigation is interrupted by a fall, which we named in honor of St. Anthony of Padua, whom we had chosen as patron of our enterprises. This fall is 50 or 60 feet in hight, and has an island of rock, in the form of a pyramid, in the middle of the chute." (See the Amsterdam edition of Hennepin's works, 1704, chapter 44, p. 319.) A translation of Hennepin's narration is found in the *Historical Collections of Louisiana, Part IV*, in which he gives "40 or 50" feet as the hight of the fall.

In the London edition of Carver's journal, 1778, p. 69, Carver thus describes the Falls of St. Anthony, as he saw them in 1766: "This amazing body of waters, which are above 250 yards over, form a most pleasing cataract; they fall perpendicularly about 30 ft., and the rapids below, in the space of 300 yards more, render

the descent considerably greater. * * * * * * In the middle of the falls stands a small island, about 40 feet broad, and somewhat longer, on which grew a few cragged hemlock and spruce trees; and about half way between this island and the eastern shore is a rock lying at the very edge of the fall in an oblique position, that appeared to be about five or six feet broad, and 30 or 40 long. * * * * At a little distance below the falls stands a small island, of about an acre and a half, on which grow a great number of oak trees, every branch of which, able to support the weight, was full of eagles' nests."

The engraving accompanying this description is that seen in *Winterbottom's America*, and is reproduced in *Harper's New Monthly Magazine for October*, 1875, and wrongly attributed to Father Hennepin. Carver's original engraving shows an island above the falls, which is omitted in the copy in Harper's. Carver states on the engraving that the breadth of the fall is about 600 feet. This engraving shows an insignificant island just in the brink of the falls, extending neither below nor above the falls, and an apparently detached block of limerock lodged on the brink between it and the eastern (or northern) shore. In the stream below the falls is represented a larger low island, not rocky, but alluvial, nearly circular, and covered with timber.

Lieut. Z. M. Pike visited the falls of St. Anthony Sept. 30, 1805. His journal, published in London in 1811, is entitled: *Exploratory Travels through the Western Territories of North America in* 1805-6-7. He says of the falls: "The Falls of St. Anthony did not strike me with that majestic appearance which I had been taught to expect from the descriptions of other travelers. On an actual survey I find the portage to be 260 poles, but when the river is not very low, boats ascending may put in 31 poles below at a large cedar tree, which would reduce it to 229 poles. The hill on which the portage is made is 69 ft. ascent, with an elevation at the point of debarkation of 45°. The fall of the water between the point of debarkation and of re-loading is 58 feet: the perpendicular fall of the chute is 16½ feet; the width of the river above the chute 627 yards, below 209. In high water the appearance is much more sublime, as the great quantity of water then forms a spray which in clear weather reflects from some positions the colors of the rainbow, and when the sky is overcast, covers the falls in gloom and chaotic majesty."

Major Stephen H. Long visited the Falls of St. Anthony in a six-oared boat in 1817. His journal, which was not published till 1860, and then by the Minnesota Historical Society, gives a more

minute description of the Falls than that of any of his predecessors. The courtesy of Rev. E. D. Neill renders it possible to give a transcript from this rare document.* "The perpendicular fall of the water at the cataract, as stated by Pike in his journal, is sixteen and a half feet, which I found to be true by actual measurement. To this hight, however, four or five feet may be added for the rapid descent which immediately succeeds the perpendicular fall within a few yards below. Immediately at the cataract the river is divided into two parts by an island which extends considerably above and below the cataract, and is about five hundred yards long. The channel on the right side of the island is about three times the width of that on the left. The quantity of water passing through them is not, however, in the same proportion, as about one-third part of the whole passes through the left channel. In the broadest channel, just below the cataract, is a small island also, about fifty yards in length and thirty in breadth. Both of these islands contain the same kind of rocky formation as the banks of the river, and are nearly as high. Besides these there are immediately at the foot of the cataract two islands of very inconsiderable size, situated in the right channel also. The rapids commence several hundred yards above the cataract, and continue about eight miles below. The fall of the water, beginning at the head of the rapids, and extending two hundred and sixty rods down the river to where the portage road commences, below the cataract, is, according to Pike, fifty-eight feet. If this estimate be correct the whole fall from the head to the foot of the rapids, is not probably much less than one hundred feet. But as I had no instrument sufficiently accurate to level, where the view must necessarily be pretty extensive, I took no pains to ascertain the extent of the fall. The mode I adopted to ascertain the hight of the cataract was to suspend a line and plummet from the table rock on the south side of the river, which, at the same time, had very little water passing over it, as the river was unusually low."

Beltrami in 1823† thus describes the Falls: "Seated on the top of an elevated promontory, I see, at half a mile distance, two great masses of water unite at the foot of an island which they encircle, and whose majestic trees deck them with the loveliest hues, in which all the magic play of light and shade are reflected on their brilliant surface. From this point they rush down a

* *Voyage of a six-oared skiff to the Falls of St. Anthony in 1817, by Major Stephen H. Long, T. E., U. S. A.*

† *A Pilgrimage in Europe and America, leading to the discovery of the sources of the Mississippi and Bloody river. J. C. Beltrami. London, 1828. Vol. 2, p. 205.*

rapid descent about 200 feet long, and, breaking against the scattered rocks which obstruct their passage, they spray up and dash together in a thousand varied forms. They then fall into a transverse basin, in the form of a cradle, and are urged upward by the force of gravitation against the side of a precipice which seems to stop them a moment only to increase the violence with which they fling themselves down a depth of twenty feet. The rocks against which these great volumes of water dash, throw them back in white foam and glittering spray; then plunging into the cavities which this mighty fall has hollowed, they rush forth again in tumultuous waves, they once more break against a great mass of sandstone forming a little island in the midst of their bed, on which two thick maples spread their shady branches."

Keating, who narrates Maj. Long's Expedition in 1823, says, (Vol II, p. 306.)

"On the 6th of July we walked to the falls of St. Anthony, which are situated nine miles (along the course of the river, seven by land) above the fort. The first glimpse which we caught of the fall was productive of disappointment, because it yielded but a partial view, but this was amply redeemed by the prospect which we obtained of it when the whole fall opened itself before us. We then discovered that nothing could be more picturesque than this cascade. We had been told that it appeared like a mere mill-dam, and we were apprehensive lest a fall of sixteen feet would lose all its beauty when extended upon a breadth of several hundred yards; but we soon observed that this was by no means the case. The irregular outline of the fall, by dividing its breadth, gives a more impressive character. An island, stretched in the river both above and below the fall, separates it into two unequal parts, the eastern being two hundred and thirty yards wide, and the western three hundred and ten. The island itself is about one hundred yards wide. From the nature of the rock, which breaks into angular, and apparently rhomboidal, fragments of a large size, this fall is subdivided into small cascades, which adhere to each other so as to form a sheet of water unrent, but composed of an alternation of retiring and salient angles, and presenting a great variety of shapes and shades; each of these forms in itself a perfect cascade, but when taken together in one comprehensive view they assume a beauty of which we could have scarcely deemed them susceptible. * * * * * * * * * Concerning the hight of the fall, and breadth of the river at this place, much incorrect information has been published. Hennepin, who was the first European who visited it, states it to be fifty or sixty feet high. It

was this traveler that gave it the name which it now bears, in honor of St. Anthony of Padua, whom he had taken for the protector of his discovery. He says of it, that it 'indeed of itself is terrible, and hath something very astonishing.' This hight is, by Carver, reduced to about 30 feet; his strictures upon Hennepin, whom he taxes with exaggeration, might with great propriety be retorted upon himself; and we feel strongly inclined to say of him, as he said of his predecessor, 'the good father, I fear, too often had no other foundation for his accounts than report, or at least a slight inspection.' Pike, who is more correct than any traveler whose steps we have followed, states the perpendicular fall at sixteen and a half feet; Major Long measured it in 1817, with a plumb line, from the table rock from which the water was falling, and found it to be the same. Mr. Colhoun measured it while we were there with a rough water level, and made it about fifteen feet. The difference of a foot is trifling, and depends upon the place where the measurement was made; but we cannot account for the statement made by Mr. Schoolcraft, that the river has a perpendicular pitch of forty feet, and this so late as fourteen years after Pike's measurement. The same author states the breadth of the river, near the brink of the fall, to be two hundred and twenty-seven yards, while Pike found it to be six hundred and twenty-seven yards, which agrees tolerably well with a measurement made on the ice. Messrs. Say and Colhoun obtained an approximate admeasurement of five hundred and ninety-four yards; this resulted from a trigonometrical calculation, the angles having been measured with a compass that was small and not nicely graduated, and the base line having been obtained under unfavorable circumstances. Below the fall the river contracts to about two hundred yards. There is a considerable rapid both above and below; a portage of two hundred and sixty poles in length is usually made here; the whole fall, or difference of level between the place of disembarking and reloading, is stated by Pike to be fifty-eight feet, which is probably very near the truth; the whole fall to the foot of the rapids, which extend several miles down the river, may be estimated as not far short of one hundred feet."

Mr. G. W. Featherstonhaugh says (*Report of a Geological Reconnoissance made in* 1835 *from the seat of government to the Coteau de Prairie:*) "An island about 450 yards long divides the Mississippi into two parts at the Falls of St. Anthony, which have a very irregular outline, owing to the soft sandstone being washed out unequally in places, and the superincumbent strata of limestone falling down in large blocks; these are piled up in large quantities

on the bed of the river immediately at the foot of the falls. That part of the river on the north side of the island is about two hundred and twenty yards in width. There is a very fine smooth section of the rocks here to the water, about 90 feet. I should think the fall would not average more than twenty feet. * * * * * On the south side of the river the line of the falls is a very irregular curvature, and measures about 450 yards to the island. The hight of the fall does not appear so great on this side, owing perhaps to the bed of the river being so much choked up with the fallen slabs. It is a wild rocky scene, but deficient in interest as a waterfall on account of its want of hight."

*Data.*

From these descriptions the following data may be eliminated:

*Hennepin,* 1680—Pyramidal island in the middle of the fall. Hight of fall 50 or 60 feet (or "40 or 50 feet.")

*Carver,* 1766—Width of river 250 yards (or "about 600 feet;") hight of the fall 30 feet; a small island in the middle of the fall 40 feet broad and "somewhat longer," with hemlock and spruce trees, and another of an acre and a half a little below the falls, with great quantities of eagles' nests; an island also above the falls; an oblique rock in the brink of the falls half way between the island and the east shore, "about five or six feet broad and thirty or forty long."

*Pike in* 1805—Portage 260 poles; waterfall 16½ feet; width of river above the falls 627 yards; below 209.

*Long in* 1817—Island 500 yards long divides the cataract and river above and below the falls; channel on the west side three times that on the east side; one-third of the water descends the east channel; waterfall 16½ feet. In the broadest channel, just below the cataract is a small island, 50 yards by 30; both islands rocky, with the same formations as in the banks, "and nearly as high;" two others of inconsiderable size immediately at the foot of the falls, both in the right channel.

*Beltrami in* 1823—Only distinctly mentions an island in the falls, and an island of sandstone below, with maples.

*Keating in* 1823—Island in the river both above and below the fall, separating it into two unequal parts, the eastern 230 yards wide, the western 310; the island is 100 yards wide; total width of river at the falls about 594 yards, with rough data; below the fall the river contracts to about 200 yards.

*Featherstonhaugh in* 1835.—Island 450 yards long divides the

fall unequally ; east channel 220 yards wide, west channel 450 ; fall 20 feet average.

* In 1856, just before the erection of permanent mills, and the diversion of the water so as to disturb the recession, the falls on the west of the island were, in general terms, abreast of the saw-mill of Farnham and Lovejoy. They had a bend upward in the center of the channel, and a sweep downward near the west shore. Their ends were nearly opposite each other. The total width of the river, including Hennepin island, was 1,700 feet at the falls. Putting together the statements of the earliest settlers, the downward sweep of the falls along the east side of the west channel met the island about 100 feet below the lowest portion of the flat undisturbed portion of the limerock on which Farnham and Lovejoy's milldam is erected, the mill itself having originally been erected in a little notch or jog in the falls, partly on the limerock and partly below the falls, close on the shore of the island. Since then the falls in the west channel have receded about 500 feet, hastened by these artificial means ; the falls on the east side, having been more protected, have not receded any perceptible amount.

Considering all these statements, and adjusting their descriptions with each other and with the known position of the Falls in 1856, before the permanent improvements for milling were made, the following conclusions may be made out :

Hennepin saw the falls in 1680, when Spirit island divided them, and their hight was much greater than now. The river gorge is 1,350 feet wide across Spirit island. The confinement of the water in this narrower channel caused the greater hight of the fall.

Carver saw the falls in 1766, just as they were leaving Spirit island and entering on Hennepin island. The "oblique rock" seen was the submerged toe, or lower, rocky end of Hennepin island. No doubt the river completely surrounded the visible part of Hennepin island, *above the brink of the falls ;* the rock, which is its substructure, only showing a small area in the fall. The rhomboidal masses, into which the limerock is cut by pre-existing jointage flaws, would very likely cause an oblique fracture along the brink, as piece after piece fell, as fully detailed by Keating in 1823 in describing the west channel. The width of the whole channel at this point, stated by Carver as about 600 feet, is 1400 feet by careful measurement. The island which Carver's engraving shows above the falls must be intended for Hennepin island which now divides the fall, but is very much out of the right position—even to

* These statements are made on the authority of Messrs. Chute, Dr. A. E. Johnson and Mr. S. W. Farnham.

represent any island. The island which his engraving shows in the brink of the falls was the upper end of Spirit island, while the low island below the falls, on which he mentions great quantities of eagles nests, can be no other than the lower end of the same island,* the narrow limerock having fallen away in the intervening space, making really (if his engraving shows correctly at this point) two parts, or islands, each being rocky. His engraving is the copy of his pencil-sketch, made probably from memory after he had left the place, and the representation of an island as *low*, which ought to have been *high* and rocky, rendered somewhat necessary to avoid the hiding of the falls, and engraved in London, would be no unexpected error, and would hardly be regarded an imperfection by any but a geologist or a professional artist. It is possible also, if his sketch was made after he left the place, *that there was really but one island of the whole.* His attention had been directed during his stay to *the island with the eagles' nests,* about which he speculates at some length in his journal, and to *the island dividing the falls.* When he came to make his sketch he represented both prominent ideas without regard to the exact manner in which they were topographically related or united; and finding that a continued *high* island would hide the west channel, (his view being from the east bank) which would materially interfere with the general effect of his illustration, he so reduced the hight of the lower portiou of the island as to make it appear like another island; the engraver then perpetuated the *appearance*, not knowing the facts. Whichever hypothesis be correct, it is not possible for the island represented in the brink of the falls, to have been Hennepin island. Besides the general agreement of the whole account with the accounts of future travelers, on the supposition of its having been Spirit island, and the statement that it was *in the middle of the falls,* Carver's engraving shows *two men in the act of portage of a canoe along the east shore,* below the falls; showing that the view presented was intended to represent the *principal fall,* (if not the whole,) while the channel on the east of Hennepin island is now, and always has been, since it began, about one-third that on the west side. Thus Carver's description, aided by his very imperfect illustration, fixes the position of the falls in 1766 at the very foot of Hennepin island.

When Lieut. Pike arrived in 1805 probably nothing remained of Spirit island in the brink of the falls, though he gives no description of the falls themselves.

In 1817, when Major S. H. Long first visited them, Hennepin

*Spirit Island (what was left of it) in 1856, was still the abode of eagles.

island divided them unequally, and Spirit island was wholly below the falls, and is described as high and rocky, with the same formations as are seen in the banks of the river. This statement demonstrates the incorrectness of Carver's engraving in this particular. If Carver did not see that high, rocky island, it never could have got there, where it exists still, between his visit and that of Long.

In 1823, Keating and Beltrami saw the falls in pretty much the same position as Long in 1817.

Again, Featherstonhaugh, in 1835, repeats the same general description.

There has been no published careful measurement of the river from Fort Snelling to St. Anthony Falls, but a lining of the map constructed by Gen. G. K. Warren, with the U. S. township and section lines represented, makes the distance almost exactly eight miles. Prof. Rhame has made for the survey a series of triangulations and chain measurements at the falls, and in the gorge below, with the view of finding the distance the falls have receded since Carver's visit to 1856, and also since Hennepin's discovery. A line across the river gorge through Spirit island may represent the position of the falls at the time of their discovery ; another across the foot of Hennepin island with an upward curve in the west channel will represent Carver's line of the falls, and another, one hundred feet below the limerock on which stands Farnham and Lovejoy's mill-dam, may represent them in 1856. It is evident that the interval between Carver's time and 1856, is the most reliable datum, the statements of Hennepin not enabling us to determine *at what point* in Spirit island the falls were when he first saw them. Still, for the purpose of comparison, a point has been assumed as that at which they were when abreast of Spirit island at the time of Hennepin's visit, and Prof. Rhame has taken measurements from it. That point is about the middle of the undisturbed limerock of the island, and 415 feet above the line of the upper end of the piers of the lower bridge immediately below, in a large re-entrant angle in the undisturbed limerock on the east side of the island, which angle runs from the top of the limerock to the bottom. The interval between Hennepin's line and that of Carver is 300 feet, between that of Carver's and that of 1856, is 606 feet, making the whole recession since Hennepin 906 feet.

### *Conclusion.*

Between Hennepin, 1680, and 1856, are 176 years ; the recession in that time was 906 feet, or an average of 5.15 feet per year.

The time needed at that rate to recede from Fort Snelling would be 8,202 years.

Between Hennepin and Carver are 86 years; the amount of recession was about 300 feet, or 3.49 feet per year. The time needed at that rate to recede from Fort Snelling would be 12,103 years.

Between Carver in 1766, and 1856, were 90 years; the recession in that interval was 606 feet, or 6.73 feet per year; at that rate it would take 6,276 years to recede from Fort Snelling.

The average of these three results is 8,859 years. Still, the exactness of the datum between Carver and 1856, is such that the actual time of such recession is probably more nearly expressed by taking that only into the calculation. This brings the glacial period to a much more recent date than some other means of calculation; but it is probable that no other datum so exact for such a calculation has ever before been used.

The only elements of possible error in this calculation are:—changes in the volume of the river, and incorrect statement for the length of the gorge between the falls and Fort Snelling.

In regard to the first of these elements of uncertainty, it is true that the river may have been larger during the first portion of its occupancy of this channel, on account of the proximity of the glacial ice, and the recession hence more rapid than during the latter; yet the width of the gorge between the rock-bluffs does not perceptibly change from Fort Snelling to the present position of the falls. Indeed, the widest portion of this gorge seems to be where the falls are at the present time. Again, the *datum* for the calculation is all taken from the latter portion of the time involved, and would more than balance any error in the opposite direction. It is not altogether certain, moreover, that an increase of the volume of water would hasten the recession. The rate of recession is dependent on the rapidity of the undermining of the limerock by the retro-action of the falling water on the loose sandrock. While the increased momentum of the water, incident to an increase of volume, would *highten* the falls, by digging deeper into the sandrock, it would by that very change remove further from the limerock the retro-action of the falls, and hence would leave a quantity of undisturbed sandrock to support longer the limerock. In regard to the second element of uncertainty, it would be found that the gorge, if measured carefully, is a little longer than eight miles rather than less.

If the occurrence of our winter in aphelion, caused by the precession of the equinoxes and the revolution of the line of the

apsides, about 11,300 years ago, was the cause of our last glacial period, the greatest *effect* of those causes which had their greatest *force* at that time, was probably felt at a considerably later date, as suggested by Prof. Rhame, in the same manner as the greatest heat of summer is not felt at the same time when the causes which produce it have their greatest activity.

This subject has been treated of by Dr. E. Andrews, in a paper read last year before the Chicago Academy of Sciences, but the writer has only seen a telegraphic newspaper notice of it. The same data employed by Dr. Andrews were furnished the writer by Mr. J. L. Gillespie, of the U. S. Engineers' office, St. Paul, and are employed and extended in the data foregoing.

The reader is referred to the Report of the Chief of Engineers, 1875, Part I, p. 385, for Gen. G. K. Warren's *Essay concerning important physical features exhibited in the valley of the Minnesota river, and upon their signification.*

*Neill's history of Minnesota from the French Explorations to the present time.*

Father Hennepin's works, published at Paris, Utrecht, London, Amsterdam, and other cities, to the number of twenty-two editions, from 1683 to 1742.

*Historical collections of Louisiana*, Part IV, contains original narratives of Hennepin and others relative to the early exploration of the Mississippi river, translated into English.

*Three years' travels throughout the interior parts of North America.* Jonathan Carver, 1766–7–8.

*Voyage in a Six-oared Skiff to the Falls of St. Anthony in* 1817. By Major Stephen H. Long. Collections of the Minnesota Historical Society.

*Narrative Journal of travels from Detroit northwest through the great chain of lakes to the sources of the Mississippi river, in* 1820. H. R. Schoolcraft.

*Narrative of an expedition to the Sources of the St. Peter, Lake Winnepeek*, &c., in 1823, under Major S. H. Long; by W. H. Keating.

*Geological Reconnoissance made in* 1835 *from the seat of government to the Coteau de Prairie.* G. W. Featherstonhaugh.

### *Material Resources. Fuel.*

There is a large annual cut of cord-wood from the timbered portions of Hennepin county, which finds market at Minneapolis and St. Paul. This comprises sugar maple, iron wood, oak, bass, elm

and soft maple. The price per cord varies with the stringency of the money market. During the past year hard wood has brought five and six dollars per cord. Osseo is an important primary wood-mart; but large quantities are hauled by the first owners directly into Minneapolis. The county is generally heavily wooded, the thinly wooded and prairie portions being along the valleys of the Mississippi and Minnesota rivers, in the southeastern portion.

*Building Stone.*

The quarries on the east side of the river, most accessible, are owned by the St. Anthony Falls Water Power Company, and are leased by them to various parties, mainly to Patterson and Baxter.

The quarries on Hennepin island are turned over to the Government for use in the tunnel, but are owned by the St. Anthony Falls Water Power Company.

The quarries on Nicollet island are owned by Eastman and Company and are worked by Henry and Abrams.

The Mississippi and Rum river Boom Company have opened some quarries near 13th street north on the east side of the river, and take from the old river bluffs, back from the river, a thin and weathered stone for their piers. There are also a great many openings in the upper portion of the E. Division, by parties owning lots that cover the brink of the Trenton terrace. In these cases attention was called to the rock generally in making excavations for cellars.

The quarries below the University a short distance, furnished the stone for the older portion of the University building. The rest of the building was constructed from quarries on Nicollet island. Quarries are now wrought below the University near the "Old Cheever Landing," by Edward Maloney, and Mr. Malone.

The quarries on the west side of the river are owned by various parties, the whole being cut up into lots according to the city subdivisions. Banks Arenson, Andrew Ernson, Michael Delaney, Holscher and Weeks, Henry Wax and George McMullen own those below the falls opposite the University.

Three-fourths of a mile below these are quarries opened by Franklin Cook and Edward Murphy.

Quarries in Sec. 32, Bloomington, are owned by H. T. Welles and by Mr. Neuser.

The stone taken from these quarries is, in general, an aluminous blue limerock, without much variation in characters. It is true that there are two or more different, distinct, strata, with different

qualities of rock, as described in giving the sections of the Lower Trenton, but the great bulk of the building stone is taken from the same stratum, about 15 ft. in thickness, which is the persistent stratum occupying the immediate brink of the Falls of St. Anthony. The rock of this stratum varies only with the degree of exposure to which it has been subjected, so far as it is seen in Hennepin county.

In the upper part of the city, along the bluffs of the old river, as in the quarries opposite Boom island, and on the county line of Anoka county, this rock is very different, to a considerable depth, from that taken out below the falls. It shows the effects of very long weathering, probably dating from pre-glacial times. These differences are all accounted for by the known effect of water and iron, with the aid of time, on the shale with which the Lower Trenton is permeated. The thin sheets of shale, which appear as dark belts of irregular and crooked direction on the newly-cut face of a "dimension stone," begin to decompose after the lapse of a number of years, causing a shattering and splitting of the whole mass. When the change takes place under the surface of the earth, but where the natural surface waters get free access, the iron that always accompanies such water, aided by the pyrites of the rock itself, gives a rusty and dirty, or yellowish color to the rock to a considerable depth. This is marked sometimes by the slow decomposition of the limestone itself, and by the sprinkling of sand or loam that covers the rock. In the face of these changes it is no wonder that a great many who have not watched them closely should be firmly persuaded that the different aspects could not be assumed by the same rock.

Stone sells from 50 cents per perch of 16½ feet (for "gray rock") to 65 cents. This is for rough, non-dimension stone. For range rock, ("blue stone,") water table, 75 cents to $1.00 per foot, cut; uncut 15 to 18 cents per foot.

### *Brick and Pottery.*

There is a small pottery establishment in upper St. Anthony, owned by Louis Kampf, the clay being taken from the Mississippi bank adjoining. The jars are light-colored, but not cream-colored.

The following brick-yards were noted in Hennepin county:

Peterson and Swansen, N. E. ¼ Sec. 12, Crystal Lake, above the mouth of Shingle creek. The brick made here are cream-colored; except, if poorly burnt, the topmost tier of the kiln has a reddish color. They are molded in water. Although this is the first year

this yard has been opened, it will turn out about 700,000. Delivered in Minneapolis these brick sell for $8.00 per thousand: at the yard for $7.00 per thousand. Mixed wood costs $2.25 to $2.50 per cord.

The Union Brick Company, (Baxter, Woodward and McNair,) Minneapolis, have made two and a half millions the present season (1876:) generally burn five millions per year. Sell for $9.00 per thousand, average price. Soft wood (basswood) costs $3.25 to $3.50 per cord; mixed wood (all kinds except hard maple and basswood) costs $3.75 to $4.00 per cord delivered at the yard. For a description of the clay the reader is referred to the drift-sections preceding. The brick are cream-colored.

Daniel Woodbury's yard is a short distance above the Union Brick Company's yard, within the valley of Bassett's creek, and he uses the same general deposit of clay, but perhaps encounters more calcareous matter in the form of concretions and bivalve shells. His brick are cream-colored, and also reddish. Mixed wood costs here $3.25, delivered; makes 400,000 per year, selling at $8.50 per thousand, or $9.00, according to the haul.

At Dayton, brick are made by Medorre Arseno, his yard being the same as that occupied 21 years ago by Lyman Dayton, situated on the north side of Crow river. The brick, which sell for $8.50 per thousand, at the kiln, are generally of a cream color, but those from the outside of the kiln are tinged with red. Two or three kilns per year are made here. Mixed wood is worth $1.50 per cord; hard wood $2.00.

In Upper St. Anthony the old brick-yard of Charles Grotjann has been closed. The brick made were red, and were not readily saleable.

Geo. Erhardt has opened a new yard at the N. end of Lake Calhoun, and sells red brick at $8.00 per thousand, or $8.50 delivered.

### *Quick-lime.*

There has been some lime burnt from the Lower Trenton at Minneapolis, but nothing is being done at the present time. There is one old pot-kiln, below the falls, within the river gorge, built of lime-rock, owned by ———

Levi Guis burns lime from boulders at Dayton. His kiln has been erected eleven years, and is emptied sometimes to the number of six times per year. He sells at Anoka, Princeton, Elk River, Monticello and Dayton, and sometimes at Minneapolis, from $1.50

to $1.75 per barrel. Another establishment of the same kind is run at Frankfort, in Wright county, by Mr. Burnings, and another at Otsego by Mr. Ingleson.

*Mills and Water-powers.*

The following extracts, from the Annual Report of the Minneapolis Board of Trade for 1876, by C. C. Sturtevant, secretary, convey a correct idea of the importance of the water-powers of Hennepin county, and particularly of the Falls of St. Anthony;

"The vast water power which has given to Minneapolis her preeminence as the great manufacturing centre of the Northwest, and is destined to make it the chief commercial city of the State, is furnished by the Mississippi river, which has a fall of 82 feet within the city limits. The volume of water passing over these falls and rapids at the ordinary stage has been estimated by competent engineers at 120,000 horse-power. Most of it can be used with the present improvements with from 40 to 60 feet head, and the entire flow is available for manufacturing purposes. The first practical use made of this power was in 1848, when a dam was built from Hennepin island to the east shore, and four saw mills erected on it. It was not till 1857, however, that the present substantial improvements were fairly inaugurated. On the 26th of February, 1856, the St. Anthony Falls Water Power Company was chartered by the Territorial Legislature, and on the 27th of the same month and year the Minneapolis Mill Company was chartered. Both charters are perpetual, the former controlling the water from the centre of the channel on the west side of Hennepin island to the east shore, the latter from the same point to the west shore.

"Robert Smith, of Alton, Illinois, was the first president of the Minneapolis Mill Company, and in 1857, W. D. Washburn, Esq., was appointed secretary and agent. The same year C. H. Bigelow, of Lawrence, Mass., a civil and hydraulic engineer, made surveys and submitted plans for improving the water-power of the Mill Company. The construction of the dam and opening of the canal, commenced in September, 1857, and the dam was completed in January, 1858. The first flouring mill (the Cataract) was built by Eastman and Gibson the same year.

"The appliances for controlling and utilizing the water-power of this company consist of a low or waste dam built on the ledge, commencing in the center of the channel of the river and connecting with the dam of the St. Anthony Water-Power Company,

thence running down stream diagonally toward the westerly shore 400 feet; thence a high dam again down the stream, parallel with the shore 500 feet, forming a pond above the mills; thence at right angels 400 feet to the pier at the head of the canal, upon which last portion is built the block of saw mills. With this dam a head of 13 feet is obtained, and a sufficient supply of water is directed to the canal, while the large proportion of the water passes over the low dam and is wasted on the falls.

"The canal is excavated along the shore 350 feet to a point opposite the brink of the fall, of a width narrowing from 80 feet to 55 feet, and below this point 500 feet further of a uniform width of 55 feet, and carrying a depth of 14 feet of water.

"The mills located upon the property improved by the Minneapolis Mill Company are as follows:

(1.) *Upon or near the canal and supplied with water therefrom.*

Sixteen Flouring Mills, 181 runs of stone.
One Woolen Mill.
One Cotton Mill.
One Iron Works.
One Railroad Machine Shop.
One Planing Mill, Sash, Door and Blind Factory.
One Paper Mill.
One 300,000 bushel Grain Elevator.
One Machine Shop.
One Mill-furnishing Shop.
One Carding Mill.

(2.) *Upon the dam of the Company:*

Seven Saw-mills, having nine gangs, seven double circulars, and other appropriate machinery; daily capacity 900,000 feet.

(3.) *Upon the river bank above the canal, and discharging water through the First street tunnel:*

One Saw Mill.
One Planing Mill.
One Machine Shop.
The City Water Works.

"The total amount of power utilized by the Company is about 4,500 horse power.

"The present officers of the Company are Gen. C. G. Washburn, President; R. J. Baldwin, Treasurer; William D. Hale, Secretary and Agent; C. C. Washburn, D. Morrison, W. D. Washburn, R. J. Baldwin and C. J. Martin, Directors.

"The improvements of the St. Anthony Falls Water Power Company consist of a dam from the east shore to Hennepin island, 400 feet up the shore of Hennepin island, 650 feet from head of island, west 200 feet, thence diagonally to the dam of the Minneapolis Mill Company, 600 feet; total length of dam, 1,850 feet. The Company has sold eight saw-mill sites on the dam in the east channel, which, together with two flouring mills, one machine shop, and other mills, renting power for manufacturing purposes, utilize about 1,300 horse power under varying heads.

"The whole water-fall on the Company's lands is 69 feet. In all further developments it will be the aim of the Company to use the water under a head of from 40 to 60 feet, voiding the water through a tunnel, or tail-race, now excavated in the sand-rock under the limestone ledge.

"The original improvements, made at an early day, amounting to some twenty mills, of different kinds, were destroyed, mainly by fire, some eight years since, and have been replaced by substantial structures. The Company are now in a condition to utilize to the highest capacity the power controlled by them, and it offers to manufacturers a field unsurpassed in the Northwest.

"The present officers of the company are Richard Chute, President; Samuel H. Chute, Agent; Ernest Ortman, Treasurer.

"In addition to the mills located on the power controlled by these companies there is one large paper mill and one double saw mill in operation. By the above it will be seen that only a small portion of this vast water-power is now in use, while the improvements of these companies have rendered the whole flow of water available."

* * * * * * * * * * *

"The permanency of this water power is now established beyond a question. There was a time when fears were expressed that the ledge which forms the falls might at some future day be swept away by the action of the water; but all apprehensions of such a catastrophe are at an end. The Government in providing for the improvement of the navigation of the river above, aided by the water power companies and the city, has now completed such works as render the falls secure for all future time."

*Flouring Mills in operation in Minneapolis in* 1876.

| | Name. | When Built. | Number Runs of Stone. | Name of Firm. |
|---|---|---|---|---|
| 1. | Cataract | 1859 | 10 | D. R. Barber and Son. |
| 2. | Union | 1860 | 5 | Darrow and Dibble. |
| 3. | Arctic | 1861 | 5 | Hobart, Shuler & Co. |
| 4. | Pillsbury | 1865 | 11 | C. A. Pillsbury & Co. |
| 5. | Minneapolis | 1865 | 9 | Crocker, Fisk & Co. |
| 6. | Washburn B | 1865 | 11 | Washburn & Hazard. |
| 7. | Dakota | 1867 | 6 | S. S. Brown & Co. |
| 8. | Zenith | 1871 | 6 | Day, Rollins & Co. |
| 9. | City | 1862 | 5 | J. C. Berry & Co. |
| 10. | North Star | 1870 | 5 | H. J. G. Crosswell. |
| 11. | Holly | 1872 | 4 | W. F. Cahill & Co. |
| 12. | Empire | 1872 | 9 | C. A. Pillsbury & Co. |
| 13. | Palisade | 1873 | 11 | L. Day & Sons. |
| 14. | Washburn A | 1873 | 41 | J. A. Christian & Co. |
| 15. | Galaxy | 1874 | 12 | W. P. Ankeny. |
| 16. | Anchor | 1874 | 12 | C A. Pillsbury & Co. |
| 17. | Hennepin | 1875 | 6 | Mills, Thompson & Co. |
| 18. | Humboldt | 1875 | 6 | Bull, Newton & Co. |
| 19. | Phœnix | 1876 | 5 | Stamwitz and Shober. |
| 20. | Pettit and Robinson | 1876 | 15 | Pettit and Robinson. |

"The product of the foregoing mills for the year 1876 was as follows:

| | Product. | Value. |
|---|---|---|
| Flour, barrels | 1,135,160 | $6,810,960 |
| Bran, tons | 50,945 | 509,450 |
| | | $7,320,410 |

"The total shipment of flour, in car lots, from Minneapolis by rail during the year 1876, amounts to 1,000,676 barrels. A large quantity is shipped in small lots, and sent out by teams, while the city consumption amounts to 40,000 barrels. There were also 50,000 barrels in store in the city. These several amounts make up the difference between the production and the shipment.

*Lumber Mills in operation in Minneapolis in 1876.*

| Owner. | Lumber. | Shingles. | Lath. |
|---|---|---|---|
| Morrison Bros. | 13,597,000 | 1,645,000 | 2,565,000 |
| J. Dean & Co | 14,128,164 | 6,955,000 | 1,650,850 |
| Pettit & Robinson | 8,000,000 | 3,500,000 | 850,000 |
| Minneapolis Lumber Co | 17,000,000 | 5,000,000 | ............ |
| J. B. Bassett | 8,500,000 | 3,000,000 | 2,000,000 |
| Eastman and Bovey | 10,200,000 | 3,000,000 | 1,300,000 |
| Farnham & Lovejoy | 23,500,000 | ............ | ............ |
| O. C. Merriman | 19,936,404 | 2,701,750 | 2,319,500 |
| Minneapolis Mill Co., two mills | 12,557,537 | 2,580,500 | 2,818,000 |
| Elias Moses | 8,000,000 | 3,000,000 | 2,000,000 |
| F. P. Clark | 11,500,000 | ............ | 2,000,000 |
| McMullen & Co | 2,000,000 | 10,000,000 | ............ |
| F. G. Mayo | 3,850,000 | 4,600,000 | 450,000 |
| Todd, Haven, Leavitt & Co | 9,500,000 | 4,500,000 | 500,000 |
| W. C. Baker, Assignee | 13,752,172 | 4,522,000 | 1,406,000 |
| Lee Brothers & Co | 500,000 | 5,000,000 | ............ |
| Wm. H. Eldred | ............ | 23,000,000 | ............ |
| Jno. Gains | 8,000,000 | 2,000,000 | 1,500,000 |
| | 184,521,277 | 85,004,250 | 21,359,350 |

"The production of lumber was the first manufacturing industry introduced into Minneapolis, and has added more largely to the population of the city than any other branch of business. The first mill was erected in 1848, but all the original mills built have given place to new and improved structures. At this time there are eighteen sawmills and one shingle mill in the city. Nearly all the saw mills have shingle and lath mills attached. The lumber product is distributed through the states of Minnesota, Iowa, Missouri, Kansas, Nebraska, and the territory of Dakota. The most of it is shipped by rail, although a small portion is rafted below the falls and floated down the Mississippi river to St. Louis and other points."

*Mills in operation in Hennepin County outside the city of Minneapolis.*

Pratt and Baird, Richfield P. O.; custom and ship to Minneapolis; 4 runs of stone; seven feet head; dam in Minnehaha creek.

Craik and Sons, Edina Mills (also known as the Red Mills;) dam in Minnehaha creek; 13 feet head; 4 runs of stone; custom and ships at Minneapolis.

Metz and Peacka, below Minnehaha Falls; dam in Minnehaha creek; 11 feet head; two runs of stone; custom.

Baxter and Northway, Champlin ; Champlin Mills ; two runs of stone ; Elm Creek power ; fall 16 feet ; shipping and custom.

Weitzel and Hurlbut, Dayton ; Dayton Mills ; Crow river power ; fall 9 feet ; five runs of stone ; ships at Itasca.

Henry Weitzel, sec. 10, Maple Grove ; Maple Grove Mills ; Elm creek power ; 12 feet fall ; two runs of stone ; custom.

McAfee and company, N. W. ¼ sec. 21, Bloomington ; Bloomington Mill ; 26 feet head ; three runs of stone.

Balm Brothers, sec. 26, Eden Prairie ; Eden Prairie Mills; two runs of stone.

Minnetonka Mill Company, Minnetonka City ; Minnetonka Mills ; dam in Minnehaha creek ; 12 feet head ; seven runs of stone ; shipping.

Herrick, Douglas & Co., on Minnehaha creek ; Globe Mills ; eight feet head ; four runs of stone ; shipping.

### *Medicinal Waters.*

Some of the springs of the county have a local repute for medicinal qualities. The Chalybeate Springs of Minneapolis consist of a copious discharge of water from the top of the shale layer between the main calcareous members of the Lower Trenton in the bluff of the river. They are situated just below the falls, on the east side of the river. The overlying layer of limerock is parted along some planes and allows the water to enter it, but the shale is nearly impervious, and sheds it. The water is not originally from the rock, but is the drainage from the drift, and the bog swamp east of St. Anthony. It probably derives its iron from the ferriferous drift of the bluffs east of St. Anthony; passes into the swamp, deposits, after evaporation, a considerable iron as a bog iron ore, and carries on what it does not leave in the swamp, penetrating the gravelly and sandy drift between the swamp and the river bank. The iron is deposited as a peroxide on the rock over which the water runs. The taste of the water is very pleasant, and is similar to that of a number of wells, which afford Chalybeate water, situated further back from the river and on the margin of the swamp. Although this water is known as Chalybeate, from the copious deposit of iron it gives on exposure to the air, yet the quantity of iron present is very small.

On analysis Mr. S. Dana Hayes, of Boston, has said: "When heated it evolves gas ; after some evaporation it becomes opalescent, and finally deposits a precipitate, while it becomes more and more alkaline. It has the chemical character, and is strictly an

*alkaline mineral water*, resembling well-known waters found in the northern part of Vermont, and in Germany and elsewhere in Europe." Mr. Hayes gives the following

*Analysis.*

"One United States gallon, or 231 cubic inches, contains nineteen and eighty-four hundredths grains of solid dry mineral matter, consisting of:

| | |
|---|---|
| Potash | 1.257 |
| Soda | 1.900 |
| Sodium | .060 |
| Lime | 5.394 |
| Magnesia | 1.589 |
| Ammonia | Trace |
| Alumina | Trace |
| Protoxide of Iron | .028 |
| Sulphuric acid | .117 |
| Chlorine | .104 |
| Silicic acid | .645 |
| Carbonic acid, combined | 8.106 |
| Crenic acid, organic | 640 |
| Total | 19.840 |

"These elements are probably combined in the water forming the following salts and compounds :

| | |
|---|---|
| Carbonate of potash | Sulphate of potash. |
| Carbonate of soda | Silicate of soda. |
| Carbonate of lime | Chloride of Sodium. |
| Carbonate of magnesia | Crenate of iron, etc. |

"All the corbonates named exist in the state of bicarbonates ; and the gases present are carbonic acid, oxygen and nitrogen ; the water containing three and three-tenths volumes of mixed gases in one hundred volumes of water. The aeration of this water renders it a pleasant beverage, and prevents the sense of heaviness after it has been drank in quantities. Beside the alternative medicinal qualities possessed by this water when taken internally, it will be found beneficial in hot and cold baths, especially in certain cases of skin disease. And it may be bottled and kept, retaining all its virtues for months without material alteration."

The Russell Mineral Spring, situated near the margin of the

same swamp, is described by Prof. Peckham on page 61, of the general report for 1876. This water has nearly the same chemical composition as that above mentioned, and within less than a grain the same total solid matter per gallon, deposits on exposure a peroxide of iron, and is probably from another drainage course from the same general reservoir—the peat marsh lying between the river and the drift bluffs, on the east side of the river.

At points a little further down the river, near the University, the water that runs down the bluff from springs issuing near the top of the bluff, deposits a calcareous tufa, which, in favorable circumstances, has become several feet thick. When the spattering water falls on moss, which often grows in such damp spots, it covers the moss with a film of carbonate of lime which, by gradually increasing, imprisons the moss, killing it, but takes its form and even its name, the moss itself gradually oxidizing and passing off in the air, as grass decays on the prairie. The deposit—loose and spongy—is then known as "Petrified Moss."

The "Great Medicine Spring," an old resort for the Indians, is situated a few miles west of Minneapolis, on the land of Mr. Wales. It also is chalybeate, but its exact chemical qualities are not known.

*Earthworks.*

Hennepin county presents a rich field for the anthropologist, a field, however, which has not been much explored. In the survey of the county artificial mounds were seen in a number of places ; the following were noted :

There are two large mounds on the south bank of Crow river, at Dayton, forty feet across and about ten feet in hight.

Four are on Mr. Aaron Hoag's land, sec. 18, Hassan.

There is another large mound on James Ream's land, two miles above Dayton, on the north side of the river.

There are a great many mounds along the Minnesota river, above Fort Snelling ; two or three on sec. 1, Bloomington ; one is on the road near Mr. Van Ness', near the line between sections 1 and 12, Bloomington They occur on Mr. Brosseau's land, sec. 14, and frequently, along the bluff, further up, as far as Shakopee at least.

There is a large mound on sec. 27, Eden Prairie, visible for some distance across the prairie.

There is a mound on S. E. ¼ sec. 1, Minnetonka, near Wayzata.

At Mound City, at the western end of Lake Minnetonka, are

"about 40" mounds on Sec 24, Minnetrista. A number of others are on Nobles island, near the same place ; others are on N. Saunders' farm near Halstead's Bay, Sec. 22. There are others at Excelsior, on P. M. Gideon's land, Sec. 28.

Some at Palmer's lake have been opened by members of the Minnesota Academy of Natural Sciences, and their contents described by Dr. A. E. Johnson. A fine specimen of a shin-bone, characteristic of the Mound-Builders was taken from a mound at Palmer lake.

On the land of James Shaver, NW. ¼ Sec. 17, Minnetonka, are a great many mounds. In the summer of 1875 a number of these were located by chain and compass by a party from the Minnesota Academy of Sciences. They were found to lie on the bluff and knolls overlooking the water of the lake, following the higher land, without regard to direction or relative position. No plan or order was discernable, though about 20 were carefully surveyed. They vary in height from two or three feet to five or six, and from ten feet in diameter to forty. There are in that neighborhood fifty or more within the area of a quarter-section of land.

Eight mounds of the same kind are seen on Widow Ferguson's land, Sec. 23, Excelsior, also overlooking the lake. Others are on NW. ¼ Sec. 11, Medina, land of Albert Johnson ; and on Samuel Barto's, Sec. 7, Minnetonka ; a large one is on the first high point east of Gale's island, on Big island.

# IX.

# REPORT ON THE GENERAL MUSEUM.

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY; FOR THE YEAR 1876.

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*By N. H. Winchell, Curator.*

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During the Fall of 1875 the cases designed for the Museum were completed so far as they had been contracted for, and during the Christmas vacation they were filled by the display of the Ward Casts. Another larger case was immediately built in the same room for the reception of the mounted mammals. Thus three sides of the room were occupied with suitable cases. In the center were placed some of the larger of the casts, including the Glyptodon, and the Mastodon, on pedestals. The Megatherium is also designed for this group, but has not yet been unboxed. It became evident at once that the room, even if supplied with all the cases it could contain, was too small to accommodate the collections on hand. The Regents have concluded therefore to carry out the original plan and to devote the other large room, across the hall from the first, to a strictly geological and mineralogical cabinet, reserving the first mainly for zoological specimens.

Several boxes of fossils belonging to the survey were opened and carefully studied and labeled during the summer, but owing to the lack of suitable cases they were retained in the geological laboratory. Mr. Herrick labeled the shells on exhibition that were purchased of H. T. Woodman, and collected about a hundred native birds. These are not mounted, but are skinned and stuffed.

The Museum has had large accessions during the year through donations and purchases at the Centennial Exhibition. Some of these specimens have been catalogued and labeled, as may be seen

by the accompanying statement, but the most of them have not. The principal donors were the following:

The Geological Survey of Canada, through A. R. C. Selwyn, Director.

The Central Pacific R. R. California.

The Pennsylvania Diamond Drill Company.

The Wisconsin Geological Survey, through Mr. E. T. Sweet.

The Pacific Guano Company.

The Kentucky Geological Survey, through John R. Proctor, Secretary of the Survey.

Tennessee Centennial Commission, through Gen. J. T. Wilder.

The Land Department of the Little Rock and Fort Smith R. R.

The Selma, Rome and Dalton R. R. Alabama.

Some minerals also were purchased at favorable rates of Mr. Herbert R. Saunders and of Prof. A. E. Foote.

The most important addition to the mineralogical collections made during the year was in the purchase of the entire cabinet collection of Mr. Geo. F. Kunz, of Hoboken, N. J. This has not been received yet at the University, and is not enumerated in the following catalogue. In general it embraces a complete set of zinc and iron ores, and species, so far as they can be got in the locality of Franklin and Ogdensburg, N. J.; also a collection prepared by the late Charles Clifton, for Owen's college, England; also a general series of mineral species in excess of the foregoing zinc and iron compounds amounting to at least 125 species, with many duplicates. Fifteen boxes of this collection have been received. There are still about twenty more. No systematic attempt has been made to catalogue the zoological specimens. The following is a list of the geological and mineralogical specimens so far as they have been examined and labeled:

# CATALOGUE OF THE GEOLOGICAL AND MINERALOGICAL SPECIMENS OF THE MUSEUM, TO DECEMBER 31, 1876.

| Serial No. | Obtained. When | Obtained. Whence. | Name. | No of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1 | 1869 ? | Dalmellington Iron Com., Ayrshire, Scotland | Black band Iron-stone | 1 | Ayrshire, Scotland | Coal Meas. | Prof. G. Campbell. |
| 2 | " | " " | " " " " calcined | 1 | " " | " | " " |
| 3 | " | " " | Iron ore | 1 | " " | " | " " |
| 4 | " | " " | Core from drill ? | 2 | " " | " | " " |
| 5 | " | " " | | 1 | " " | " | " " |
| 6 | " | " " | Calamites sp. ? | 2 | " " | " | " " |
| 7 | " | " " | Lepidodendron sp. ? | 1 | " " | " | " " |
| 8 | " | " " | Lepidodendron sp. ? | 1 | " " | " | " " |
| 9 | " | " " | | 1 | " " | " | " " |
| 10 | " | " " | | 1 | " " | " | " " |
| 11 | " | " " | (Conchifers) | 7 | " " | " | " " |
| 12 | " | " " | No. 1 Pig Iron | 1 | " " | " | " " |
| 13 | " | New Commock, Ayrshire. | Lammark Cannel Coal | 1 | " " | " | " " |
| 14 | " | Dundee, Scotland | Shark's tooth | 1 | Dundee, Scotland | | " " |
| 15 | " | Dalmellington, Scotland | Iron ore. (Haematite) with quartz | 4 | Ayrshire, Scotland | | " " |
| 16 | " | | Cinnabar | 2 | Europe | | " " |
| 17 | " | | Iron pyrites | 5 | " | | " " |
| 18 | " | | Pyritiferous conglomerate. (Auriferous) | 3 | " | | " " |
| 19 | " | | Iron ore. "Parkside" | 1 | Whitehaven, Eng. | | " " |
| 20 | " | | Chert, flinty | 1 | Whitehead, Ireland. | | " " |
| 21 | " | Rome, Italy | Samples of the building-stone of ancient Rome, Palaces about the Forum and Palatine Hill | 20 | | | " " |
| 22 | " | | Orthis and Strophomena | 3 | | Trenton | " " |
| 23 | " | | Ormoceras tenuifilum, Hall. (Cephalopod) | 2 | | " ? | " " |
| 24 | " | H. P. Van Cleve | Endoceras magniventrum, H. " | 1 | Mendota, Minn | Trenton | |
| 25 | " | | Leptaena deltoidea. Con | 1 | Minneapolis | " | Records doubtful, |
| 26 | " | | Calcite | Many | | Metamorphic. | No records of any kind. |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 27 | | | Amygdaloid with Epidote | 1 | | Metamorphic. | No records. |
| 28 | | | Amygdaloid with Epidote. | 2 | | " | " " |
| 29 | | | Calcite as a segregated vein in Argillite. | 1 | | " | " " |
| 30 | | | Calcite in Argillite (or Jasper) | 1 | | | " " |
| 31 | | | Porphyrytic Granite | 1 | | | " " |
| 32 | | | Franklinite | 1 | Franklin, N. J. | | " " |
| 33 | | | Syenite | 1 | | | " " |
| 34 | | | Marble (rosy) | 1 | | | " " |
| 35 | | | Quartzite | 1 | | | " " |
| 36 | | | Mica Schist | 1 | | | " " |
| 37 | | | White Sandstone | 1 | | | " " |
| 38 | | | Grit | 1 | | | " " |
| 39 | | | Conglomerate | 1 | | | " " |
| 40 | | | Marble (reddish) | 1 | | | " " |
| 41 | | | Marble (white) | 4 | | | " " |
| 42 | | | Hydromia Slate | 1 | | | " " |
| 43 | | | Catlinite | 1 | Pipestone Co., Minn. | Potsdam | " " |
| 44 | | | Syenite ? | 1 | St. Cloud | | Seems to contain only Labordorite and Quartz. |
| 45 | | | Granite ? | 1 | | | No records of any kind. |
| 46 | | | Calciferous Sandrock | 1 | | Lower Mag | " " " |
| 47 | | | Gypsum | 2 | Fort Dodge, Iowa | | " " " |
| 48 | | | Gneiss | 1 | | | " " " |
| 49 | | | Grit | 1 | | | " " " |
| 50 | | | Pyrites and Chert | 1 | | | " " " |

## *Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 51 | | | Quartz in Greenstone | 1 | | | No records of any kind. |
| 52 | | | Saccharoidal marble | 1 | | | " " |
| 53 | | | Serpentine rock, (Ophiolyte.) | 1 | | | " " |
| 54 | 1872 | J. F. Kenworthy | | 4 | | Hamilton | Records in doubt. |
| 55 | " | " | | 2 | | " | " " |
| 56 | " | " | | 17 | | " | " " |
| 57 | " | " | | 4 | | " | " " |
| 58 | " | " | | 10 | | " | " " |
| 59 | " | " | | 7 | | " | " " |
| 60 | " | " | | 1 | | " | " " |
| 61 | " | " | | 1 | | " | " " |
| 62 | " | " | | 7 | | " | " " |
| 63 | " | " | | 1 | | " | " " |
| 64 | " | " | | 2 | | " | " " |
| 65 | " | " | | 1 | | " | " " |
| 66 | " | " | | 56 | | " | " " |
| 67 | " | " | | 1 | | " | " " |
| 68 | | | Haematite (botryoidal) | 1 | | | No records whatever. |
| 69 | | | Galenite | 23 | | | " " |
| 70 | | | Calcite | 2 | | | " " |
| 71 | | | Pyrite | 9 | | | " " |
| 72 | | | Pyrite and Galenite | 1 | | | " " |
| 73 | | Dr. Stoneman | Glass quartz | 2 | | | Records doubtful. |
| 74 | | " | Strophomena alternata. Con. | 1 | | Trenton | " " |
| 75 | | " | Strophomena alternata. Con. | 1 | | " | " " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 76 | | | Lead | 1 | | Trenton ? | Records doubtful. |
| 77 | | Dr. Stoneman | Cyathophylloids | 3 | | " | " " |
| 78 | | " " | Chaetetes sp.? | 2 | | " | " " |
| 79 | | " " | Chaetetes Lycoperdon. H. | 7 | | " | " " |
| 80 | | " " | Chaetetes sp.? | 1 | | " | " " |
| 81 | | " " | Crinoid stems | 3 | | " | " " |
| 82 | | " " | Orthis lynx | 1 | | " | " " |
| 83 | | " " | Resembles in shape Pleurotomaria subconica. | 2 | | | Has not the proper surface markings. |
| 84 | | " " | Murchisonia ventricosa. H. (or perangulata.) | 1 | | | Records doubtful. |
| 85 | | " " | Drusy Quartz | 1 | | | " " |
| 86 | | " " | Native Copper | 1 | | | " " |
| 87 | | " " | Barite | 2 | | | " " |
| 88 | | " " | Selenite | 1 | Kansas | | " " |
| 89 | | " " | Endoceras angusticameratum. H. | 1 | | Trenton | " " |
| 90 | | " " | Fossiliferous Limestone | 1 | | " | " " |
| 91 | | " " | ? | 1 | | " | " " |
| 92 | | " " | Quartzite pebble | 1 | | | " " |
| 93 | | " " | Conglomerate | 1 | | | " " |
| 94 | | " " | Strophomena sp.? | 2 | | | " " |
| 95 | | " " | Strophomena sp.? | 8 | | | " " |
| 96 | | " " | Strophomena sp.? | 3 | | | " " |
| 97 | | Prof. Beardsley | "Variegated marble" | 1 | West Rutland, Vt. | | |
| 98 | | " " | "Traprock" | 1 | Mt. Holyoke, Mass. | | |
| 99 | | " " | New Red Sandstone | 1 | | | |
| 100 | | " " | Conglomerate. New Red Sandstone | 1 | Mt. Holyoke, Mass. | | |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. | | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 101 | | Prof. Beardsley | "Jasper" | 1 | W. Rutland, Vt. | | |
| 102 | | " " | "Chalcopyrite" | 1 | S. Hampton, Mass. | | |
| 103 | | " " | "Copper Pyrites" | 2 | " " | | |
| 104 | | " " | Chalcopyrites and Chrysocolla | 1 | ? | | |
| 105 | | " " | "Serpentine" | 1 | Chester, Mass. | | |
| 106 | | " " | "Margarite" | 5 | " " | | |
| 107 | | " " | "Muscovite and Quartz" | 1 | ? | | |
| 108 | | " " | "Soapstone with Garnets" | 1 | Chester, Mass. | | |
| 109 | | " " | "Garnets" in Soapstone | 1 | " " | | |
| 110 | | " " | "Talc" | 1 | " " | | |
| 111 | | " " | "Steatite" | 1 | " " | | |
| 112 | | " " | "Emery" | 1 | " " | | |
| 113 | | " " | "Hornblende" | 1 | " " | | |
| 114 | | " " | "Serpentine" | 1 | " " | | |
| 115 | | " " | "Emery Mine" | 1 | " " | | |
| 116 | | " " | "Corundum" | 4 | " " | | |
| 117 | | " " | "Corundum" | 1 | " " | | |
| 118 | | " " | "Galena" | 2 | S. Hampton, Mass. | | Lead Mines at S. Hampton. |
| 119 | | " " | "Talcose Schist" | 2 | " " | | |
| 120 | | " " | Calcite on opalescent and drusy Quartz | 1 | " " | | |
| 121 | | " " | Quartz | 2 | " " | | |
| 122 | | " " | Calcite and (actinolite ?) | 1 | " " | | |
| 123 | | " " | | 1 | " " | | |
| 124 | | " " | "Galena" | | " " | | |
| 125 | | Burdett Thayer | Large crystal of Quartz | | Near Montreal, Ont. | | |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 126 | Oct. 1872.. | Geol. Sur .......... | Endoceras magniventrum. Hall .... | 3 | Mantorville .................... | Galena..... | N. H. Winchell. |
| 127 | " | W. D. Hurlburt.. ... | Endoceras magniventrum. Hall.... | 1 | Near Rochester........ ........ | " .... | " |
| 128 | " | " ...... | ........................................ | 1 | " ........ ........ | " .... | " |
| 129 | " | Geol. Sur........... | ........................................ | 1 | Mantorville.................... | " .... | " |
| 130 | " | " " ........ | ........................................ | 1 | Mantorville ? .. ........ ....... | Trenton ... | " |
| 131 | " | " " ........... | Orthoceras multicameratum. Con. | 1 | Pettit's Mill..... ....... ..... | " ... | " |
| 132 | Sept. 1875 | " " ........... | Endoceras magniventrum. Hall.... | 9 | Sec. 7, Viola, Olm. Co..... .... | Galena..... | M. W. Harrington. |
| 133 | " | W. P. Farrell........ | Endoceras proteiforme. Hall....... | 2 | NE¼, Sec. 32, Dover, Olm. Co.. | " .... | M. W. Harrington. |
| 134 | Oct. 1875. | John Kleckler.. .... | Lituites undatus. Con............. | 1 | 2 ms. N.E. Spring Valley...... | Trenton ... | N. H. Winchell. |
| 135 | Sept. 1875 | Geol. Sur............ | Endoceras magniventrum. Hall.... | 1 | Sec. 7, Viola, Olm. Co ...... | Galena..... | M. W. Harrington. |
| 136 | " | " " ........... | ........................................ | 2 | ................................ | " .. | " |
| 137 | Oct. 1875. | " " ........... | Endoceras magniventrum. Hall.... | 2 | Fountain, Fill. Co............ | Trenton ... | N. H. Winchell, |
| 138 | " | John Kleckler....... | Endoceras distans................. | 1 | 2 ms. N.E. Spring Valley...... | " ... | " |
| 139 | Oct. 1872. | Geol. Sur......... ... | Endoceras magniventrum. Hall.... | 1 | Mantorville... ............... | Galena..... | " |
| 140 | Oct. 1875. | John Kleekler ....... | ........................................ | 1 | 2 ms. N.E. Spring Valley...... | Trenton ... | " |
| 141 | " | " " ....... | ........................................ | 1 | " " " ...... | " .. | " |
| 142 | Sept. 1875 | Geol. Surv........... | Endoceras magniventrum. Hall.... | 1 | Olmsted Co............ ...... | " ... | M. W. Harrington. |
| 143 | " | Rev. H. P. Satchwell. | ........................................ | 1 | Salem, Olm. Co........ ....... | " ... | " (Quarry of John Vosburg.) |
| 144 | " | Geol. Surv........... | Endoceras proteiforme. Hall....... | 4 | Cascade, Olm. Co....... ....... | " ... | " (Jenkins' Quarry.) |
| 145 | Jan. 1876 | S. H. Chute.......... | Endoceras magniventrum. Hall.... | 2 | Minneapolis, E................. | " ... | N. H. Winchell (From green shales.) |
| 146 | ......... | W. P. Farrell........ | Receptaculites sp.? .... ......... | 1 | N.E.¼, Sec. 32, Dover, Olm. Co. | Galena..... | M. W. Harrington. |
| 147 | 1875...... | Geol. Surv .......... | Receptaculites Oweni. Hall......... | 8 | Sec. 7, Viola, Olm. Co ........ | " .... | " |
| 148 | 1875...... | " " ......... | ........................................ | 1 | Fillmore Co.................... | " .... | N. H Winchell. |
| 149 | 1875...... | Geo. Shepard....... | ........................................ | 1 | " ................. | " .... | " |
| 150 | 1875...... | Geol. Surv........... | Receptaculites occidentalis. Sal ... | 1 | Jordan, Fillmore Co .......... | Trenton ... | " |

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*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 151 | Oct. 1875 | Geol. Surv. | Chaetetes ? | 2 | Chatfield | Trenton | N. H. Winchell. |
| 152 | Sept. " | " " | Receptaculites Oweni. Hall | 2 | Sec. 17, Rochester, Olm. Co. | Galena | M. W. Harrington. |
| 153 | " " | " " | Réceptaculites Oweni. Hall | 1 | " " " | Galena | " |
| 154 | Oct. " | " " | 'Receptaculites globularis. H." (After M. & W.) | 1 | Chatfield | L. Trenton | N H. Winchell. (Ill. Rep., Vol. III, p. 301.) |
| 155 | Sept. " | " " | Endoceras proteiforme. Var. strangulatum. H. | 1 | Cascade, Olmsted Co. | L. Trenton | M. W. Harrington. (Jenkins' q'ry.) |
| 156 | Oct. " | " " | | 1 | Sec. 20, Beaver, Fill. Co. | Devonian | N H. Winchell. |
| 157 | Sept. " | " " | Receptaculites Oweni. Hall | 1 | Sec. 17, Rochester, Olm. Co. | Galena | M. W. Harrington. (Garrick's q'ry.) |
| 158 | " " | " " | Receptaculites. sp. ? | 1 | " " " | Galena | " " |
| 159 | " " | " " | Ormoceras tenuifilium. Hall | 2 | " " " | Gray Limestone. | " (below Garrick's q.) |
| 160 | " " | " " | Receptaculites. sp. ? | 1 | " " " | Galena | " (Garrick's q'ry ) |
| 161 | " " | " " | Receptaculites Oweni. Hall | 4 | " " " | Galena | " " |
| 162 | " " | " " | Petraia corniculum. Hall | 1 | " " " | Galena | " " |
| 163 | " " | " " | Illaenus latidorsata. Hall ? | 1 | " " " | Galena | " " |
| 164 | " " | " " | Receptaculites Oweni. Hall | 1 | Olmsted county | Galena | " " |
| 165 | Oct. " | " " | Maclurea magna. Hall | 1 | Weisbach's Mill, Fill. Co. | Trenton | N. H. Winchell. |
| 166 | July " | " " | Maclurea magna ? | 1 | Northfield ? | Shakopee | " |
| 167 | Sept. " | " " | Receptaculites occidentalis. Sal. ? | 2 | Manterville, Dodge Co. | Galena | S. Wilson. |
| 168 | " " | " " | Conularia Trentonensis. Hall | 1 | " " Wilson's quarry. | Galena | The longitudinal striæ are not quite like the figures of Hall, Plate 59. M. W. Harrington. (Upper layer.) |
| 169 | " " | " " | Receptaculites. sp. ? | 1 | Rochester, Olmsted Co | Galena | M. W. Harrington. |
| 170 | Oct. " | " " | Chaetetes. ? | 1 | 2 miles N. E. Spring Valley. | Trenton | N. H. Winchell. |
| 171 | ept. " | " " | | 2 | No. 7, Viola, Olm. Co | Galena | M. W. Harrington. |
| 172 | " " | " " | | 1 | " " " | Galena | " |
| 173 | Oct. " | " " | Productus. ? | 4 | Spring Valley | Galena. ? | N. H. Winchell. |
| 174 | Sept. " | " " | Strophomena. sp. ? | 1 | Garrick's quarry, Rochester | Galena | M. W. Harrington. |
| 175 | Oct. " | " " | | 1 | Etna, Fillmore Co | Drift | N. H. Winchell. |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 176 | 1875 | Geol. Sur. | Murchisonia bicincta. Hall.<br>Isotelus gigas. Hall. Orthis?<br>Streptelasma corniculum. H. Leptaena?<br>Murchisonia perangulata. Hall<br>Murchisonia angustata. H. | 2 | Rochester, (Garrick's quarry.) | Galena | M. W. Harrington. |
| 177 | " | " | Rhynchonella sp. ? | 1 | " " | " | " " |
| 178 | " | " | Murchisonia bellicincta. Hall | 1 | " " | " | " " Shows no siphuncle. |
| 179 | " | " " | Non-septate, portion of an orthoceras shell. | 1 | " " | " | " " |
| 180 | 1872 | " " | Strophomena deltoidea. Con. | 1 | Minneapolis | Trenton | N. H. Winchell. |
| 181 | " | " " | " recta. Con. | 2 | St. Charles | " | N. H Winchell. Cast of the interior of the concave or ventral valve with the crenulated striæ of the dorsal valve preserved on the margin. Pal. Foss. p. 130. |
| 182 | 1875 | " " | " alternata. Con. | 1 | Rochester, (Garrick's quarry.) | Galena | M. W. Harrington. |
| 183 | " | " " | Pleurotomaria umbilicata. Hall | 1 | " " | " | " " |
| 184 | " | " " | " ambigua. Hall.<br>(or umbilicata.) | 1 | " " | " | " " |
| 185 | " | " " | | 8 | Fillmore County | Trenton | N. H. Winchell. |
| 186 | " | " " | | 1 | " " | " | " " |
| 187 | " | " " | Orthis ? | 1 | " " | Galena | " " |
| 188 | " | " " | | 1 | Spring Valley | " | " " |
| 189 | " | " " | | 1 | Fillmore County | Trenton | " " |
| 190 | " | " " | | 1 | " " | " | " " |
| 191 | " | " " | | 1 | " " | " | " " |
| 192 | " | " " | | 1 | " " | " | " " |
| 193 | " | " " | Strophomena sp. ? | 1 | " " | " | " " |
| 194 | " | " " | | 1 | " " | " | " " |
| 195 | " | " " | | 1 | " " | " | " " |
| 196 | " | " " | Pleurotomaria lenticularis. Con. | 1 | " " | " | " " |
| 197 | " | " " | Orthoceratite ? | 1 | " " | " | " " |
| 198 | ...... | " " | | 1 | Spring Valley | " | " " |
| 199 | ...... | " " | Strophomena deltoidea. Con | 3 | Minnehaha | " | " " |
| 200 | ...... | " " | | 1 | " | " | " " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 31, 1876.*—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 201 | ............ | Geol. Surv. ........ | Strophomena deltoidea. Con. .............. | 1 | Minnehaha .................... | Trenton.... | N. H. Winchell. |
| 202 | ............ | " " ........ | Edmondiea subtruncata. Hall ?.............. | 2 | " .................... | " ... | " |
| 203 | ............ | " " ........ | Strophomena deltoidea. Con... ............ | 2 | " .................... | " ... | " |
| 204 | 1875. | " " ........ | " tenuistriata, Sow. (allied to) | 2 | Sec. 17, Rochester, Olmsted Co | Galena.... | M. W. Harrington. |
| 205 | " | " " ........ | Receptaculites ?........................ | 1 | " " | " .... | M. W. Harrington. |
| 206 | " | " " ........ | Chaetetes Sp, ?........................ | 1 | Finn's Glen, Minneapolis...... | Trenton.... | N. H. Winchell. |
| 207 | " | " " ........ | Petraia corniculum. Hall........ .......... | 1 | Sec. 17, Rochester, Olmsted Co | Galena..... | M. W. Harrington. |
| 208 | " | " " ........ | ........................................ | 1 | " " | " .... | " |
| 209 | " | " " ........ | Strophomena tenuistriata ?............... Phacops rana ? | 1 | " " | " | " |
| 210 | " | " " ........ | ........................................ | 1 | High Forest.................. | ............ | ........................ |
| 211 | " | " " ........ | Chaetetes petropolitanus. Pand... ........ | 1 | 2 miles N. E. Spring Valley... | Trenton.... | N. H. Winchell. |
| 212 | " | " " ........ | ........................................ | 1 | " " " ... | " .... | " |
| 213 | " | " " ........ | Endoceras distans. Hall.................. | 1 | " " " ... | " .... | " |
| 214 | " | " " ........ | ........................................ | 1 | Spring Valley...... ........... | Galena..... | " |
| 216 | " | " " ........ | Pleurotomaria umbilicata. Hall,........... | 1 | St. Anthony .................. | Trenton.... | " |
| 217 | " | " " ........ | ........................................ | 1 | Rochester, (Garrick's Quarry) | Galena..... | M. W. Harrington. |
| 218 | Oct. 1872. | " " ........ | Murchisonia subfusiformis. Hall.......... | 1 | Mantorville, (Pettit's Mill).... | Trenton.... | N. H. Winchell, (compare 343 and 255.) |
| 219 | " | " " ........ | ........................................ | 1 | " " .. | " ".. | M. W. Harrington. |
| 220 | Sept. 1875. | " " ........ | Orthis, Leptaena nucleata (?)............. Productus. Atrypa. 428 and 299. | 1 | Sec. 29, Bloomfield .......... | Galena ?... | N. H. Winchell. |
| 221 | ............ | " " ........ | ........................................ | 1 | Chester, Iowa................ | Devonian.. | " |
| 222 | ............ | " " ........ | ........................................ | 1 | " " ............... | " .. | " |
| 223 | ............ | " " ........ | ........................................ | 2 | " " ............... | " .. | " |
| 224 | ............ | " " ........ | ........................................ | 1 | " " ............... | " .. | " |
| 225 | Oct. 1875. | " " ........ | ........................................ | 1 | " " ............... | " .. | " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. | | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 226 | Oct. 1875 | Geol. Surv. | | 2 | Forreston, Iowa | Galena | N. H. Winchell. |
| 227 | " | " " | Spirifer. Productus and Leptaena nucleata? | 1 | Spring Valley | " ? | " |
| 228 | " | " " | Strophomena sp.? | 1 | Fillmore County | Trenton | " |
| 229 | " | " " | Spirifer sp.? | 1 | Spring Valley | Galena? | " |
| 230 | " | " " | " | 1 | " " | " | " |
| 231 | " | " " | Orthis testudinaria. Dal | 1 | " " | Galena | " |
| 232 | " | " " | Strophomena fluctuosa. Bill | 1 | " " | " | " |
| 233 | June, 1 73 | " " | Cyclonema? | 1 | Finn's Glen, Minneapolis | Trenton | " |
| 234 | " | " " | Spirifer sp.? | 1 | Spring Valley | Galena? | " |
| 235 | Oct. 1875 | " " | Productus sp.? (distorted.) | 1 | " " | " ? | " |
| 236 | " | " " | Orthis testudinaria. Dal | 1 | " " | Galena | " |
| 237 | " | " " | | 1 | " " | " | " |
| 238 | " | " " | Spirifer and Productus | 1 | " " | Galena? | " |
| 239 | " | " " | | 1 | Chatfield | Trenton | " |
| 240 | " | " " | | 6 | High Forest | | " |
| 241 | " | " " | Orthoceras, with remains of trilobites | 2 | Holden, Goodhue Co. | Trenton | " |
| 242 | " | " " | | 2 | " " | " | " |
| 243 | " | " " | | 1 | " " | " | " |
| 244 | " | " " | | 1 | " " | " | " |
| 245 | " | " " | | 3 | " " | " | " |
| 246 | " | " " | | 1 | " " | | " |
| 247 | " | " " | | 1 | " " | | " |
| 248 | " | " " | | 3 | Sec. 20, Beaver, Fillmore Co. | Devonian | " |
| 249 | " | " " | | 5 | " " | " | " |
| 250 | " | " " | | 2 | " " | " | " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 251 | Oct. 1875 | Geol. Surv. | Maclurea Logani. Sal | 14 | Lime City, Fillmore Co. | Trenton | N. H. Winchell. |
| 252 | July 1875 | " " | | 1 | Holden, Goodhue Co. | " | " " |
| 253 | Oct. 1875 | " " | Maclurea magna. Hall | 1 | Lime City, Fillmore Co. | " | " " |
| 254 | " " | " " | | 1 | " " | " | " " |
| 255 | " " | " " | Murchisonia subfusiformis. Hall? | 1 | " " | " | " " compare 343 & 318 |
| 256 | " " | " " | Receptaculites occidentalis. Sal. | 1 | " " | " | " " |
| 257 | " " | " " | Receptaculites Oweni. Hall | 1 | " " | " | " " |
| 258 | " " | " " | | 3 | " " | " | " " |
| 259 | " " | " " | Chaetetes Lycoperdon. Hall | 37 | Fillmore, Fill. Co., (Shepherd's quarry) | " | " " |
| 260 | Sept. 1875 | " " | Fragment of trilobite shield? | 1 | Mantorville | Galena | M. W. Harrington. |
| 261 | " " | " " | Strophomena sp.? | 1 | " | " | " " |
| 262 | " " | " " | " fluctuosa. Bill. | 1 | " | " | " " |
| 263 | " " | " " | Discina Pelopea. Bill. | 1 | " | " | " " |
| 264 | Sep. 1875 | " " | | 2 | Olmsted Co. | Trenton | " " |
| 265 | Oct. 1875 | " " | | 2 | Sec. 26, Bloomfield, Fill. Co. | Galena | N. H. Winchell. |
| 266 | " " | " " | Rhynchonella capax. Con. (increbescens of Hall.) Has the internal markings of Atrypa but the shape of a Rhynchonella. ? (Eatonia ?) | | Fillmore, Fill. Co. | Trenton | " " |
| 267 | " " | " " | | 24 | Spring Valley | Galena? | " " |
| 268 | " " | " " | | 1 | Sec 26, Bloomfield | " | " " |
| 269 | " " | " " | | 1 | Sec. 30, Forestville, Fill. Co. | Trenton | " " |
| 270 | " " | " " | Same as No. 267, (shows a number of fragments) | 2 | Spring Valley | Galena? | " " |
| 271 | " " | " " | Slab with Strophomena sp.? | 1 | Mantorville, Dodge Co. | Trenton | M. W. Harrington. |
| 272 | " " | " " | Orthis testudinaria. Dal | Indefinite | Spring Valley | Galena | N. H. Winchell. |
| 273 | " " | " " | Orthis plicatella. Hall | 1 | " " | " | The dorsal beak is but slightly more prominent than that of the ventral valve. The casts of the interior of the dorsal valve are not with a "subquadrangular visceral impression" Pal. N. Y. I., p. 126. |
| 274 | " " | " " | " subquadrata. Hall. ? | Indefinite | " " | " | The areas seem not to form an angle greater than 90°. |
| 275 | " " | " " | Strophomena nitens. Bill? | 3 | " " | " | |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | OBTAINED. When. | OBTAINED. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 276 | Oct. 1875 | Geol. Surv. | Petraia. ? | 1 | Spring Valley | Galena | N. H. Winchell. |
| 277 | " " | " " | Cast of an Orthis. (not subquadrata.) | 1 | " | " | " |
| 278 | " " | " " | Orthis Plicatella. Hall. (v. 278.) | 2 | " | " | " |
| 279 | " " | " " | | 4 | " | " | " |
| 280 | " " | " " | Leptaena nucleata. (v. 290) | 2 | Sec. 22, Bloomfield | " ? | " |
| 281 | " " | " " | Chaetetes. (Or Bolboporites, Geol. Can., p. 124.) | 3 | Minneapolis | Trenton | " |
| 282 | " " | " " | Chaetetes Lycoperdon. Hall | 1 | " | " | " |
| 283 | " " | " " | Rhynchonella capax. Con. | 1 | " | " | " |
| 284 | Sept. " | " " | Murchisonia bellicincta. Hall | 1 | Sumner tp., Fillmore Co. | " | Geo. Ten Eyck. (N. H. W.) |
| 285 | " " | " " | Pleurotomaria. sp. ? | 1 | " " | " | " " |
| 286 | " " | " " | (Resembles Macrocheilus.) | 1 | " " | " | " " |
| 287 | " " | " " | Strophomena alternata. Con. | 1 | " " | " | " " |
| 288 | " " | " " | Maclurea Logani. Sal. (with a Strophomena attached). | 1 | " " | " | " " |
| 289 | " " | " " | | 1 | Wasioja, Dodge Co. | Galena | M. W. Harrington. |
| 290 | " " | " " | Orthis. sp. ? | 1 | Rochester. (Garrick's q.) | " | " |
| 291 | " " | " " | Lingula quadrata. Eich | 3 | Olmsted Co | Trenton | W. D. Hurlburt. |
| 292 | " " | " " | Chaetetes. (And a fucoidal fragment.) | 5 | Sec. 25, Cascade, Olm. Co. | | M. W. Harrington. |
| 293 | " " | " " | | 2 | Mantorville, Dodge Co. | Galena | " (Upper layers Wilson's quarry.) |
| 294 | " " | " " | | 1 | " " | " | M. W. Harrington. |
| 295 | " " | " " | | 1 | " " | " | " |
| 296 | " " | " " | | 1 | " " | " | " |
| 297 | " " | " " | Strophomena fluctuosa. Bill | 1 | " " | " | N. H. Winchell—Has a part ot a pygidium of a trilobite. |
| 298 | Oct. " | " " | | 1 | High Forest | | N. H. Winchell. |
| 299 | " " | " " | Atrypa ? Eatonia ? (v. 220 and 426) | 2 | Sec. 22, Bloomfield ? | Galena ? | " |
| 300 | " " | " " | | 1 | " " | " | " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|---|
| 251 | Oct. | 1875 | Geol. Surv. | Maclurea Logani. Sal | 14 | Lime City, Fillmore Co | Trenton | N. H. Winchell. |
| 252 | July | 1875 | " " | .......... | 1 | Holden, Goodhue Co | " | " " |
| 253 | Oct. | 1875 | " " | Maclurea magna. Hall | 1 | Lime City, Fillmore Co | " | " " |
| 254 | " | " | " " | .......... | 1 | " " | " | " " |
| 255 | " | " | " " | Murchisonia subfusiformis. Hall? | 1 | " " | " | " " compare 343 & 318 |
| 256 | " | " | " " | Receptaculites occidentalis. Sal | 1 | " " | " | " " |
| 257 | " | " | " " | Receptaculites Oweni. Hall | 1 | " " | " | " " |
| 258 | " | " | " " | .......... | 3 | " " | " | " " |
| 259 | " | " | " " | Chaetetes Lycoperdon. Hall | 37 | Fillmore, Fill. Co., (Shepherd's quarry) | " | " " |
| 260 | Sept. | 1875 | " " | Fragment of trilobite shield? | 1 | Mantorville | Galena | M. W. Harrington. |
| 261 | " | " | " " | Strophomena sp.? | 1 | " | " | " " |
| 262 | " | " | " " | " fluctuosa. Bill | 1 | " | " | " " |
| 263 | " | " | " " | Discina Pelopea. Bill | 1 | " | " | " " |
| 264 | Sep. | 1875 | " " | .......... | 2 | Olmsted Co | Trenton | " " |
| 265 | Oct. | 1875 | " " | .......... | 2 | Sec. 26, Bloomfield, Fill. Co | Galena | N. H. Winchell. |
| 266 | " | " | " " | Rhynchonella capax. Con. (increbescens of Hall.) Has the internal markings of Atrypa but the shape of a Rhynchonella. ? (Eatonia ?) | .......... | Fillmore, Fill. Co | Trenton | " " |
| 267 | " | " | " " | .......... | 24 | Spring Valley | Galena? | " " |
| 268 | " | " | " " | .......... | 1 | Sec 26, Bloomfield | " | " " |
| 269 | " | " | " " | .......... | 1 | Sec. 30, Forestville, Fill. Co | Trenton | " " |
| 270 | " | " | " " | Same as No. 267, (shows a number of fragments) | 2 | Spring Valley | Galena? | " " |
| 271 | " | " | " " | Slab with Strophomena sp.? | 1 | Mantorville, Dodge Co | Trenton | M. W. Harrington. |
| 272 | " | " | " " | Orthis testudinaria. Dal | Indefinite | Spring Valley | Galena | N. H. Winchell. |
| 273 | " | " | " " | Orthis plicatella. Hall | 1 | " " | " | The dorsal beak is but slightly more prominent than that of the ventral valve. The casts of the interior of the dorsal valve are not with a "subquadrangular visceral impression" Pal. N. Y. I., p. 126. |
| 274 | " | " | " " | " subquadrata. Hall. ? | Indefinite | " " | " | The areas seem not to form an angle greater than 90°. |
| 275 | " | " | " " | Strophomena nitens. Bill? | 3 | " " | " | |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When | Obtained. Whence. | Name. | Number of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 326 | 1876. | Geol. Surv... | ........................................ | 2 | Minneapolis .............. | Trenton... | N. H. Winchell. |
| 327 | " | " " .. | ........................................ | 2 | " ...................... | " .. | " |
| 328 | " | " " .. | Atrypa. ?..................(v. 220)........... | 1 | " ...................... | " .. | " |
| 329 | " | " " .. | ........................................ | 1 | Spring Valley ................ | ........... | J. Kleckler. |
| 330 | 1873. | " " .. | Chaetetes Lycoperdon. Hall.................. | Indefinite. | Finn's Glen, Minneapolis ....... | " .. | N. H. Winchell. |
| 331 | " | " " .. | ........................................ | 6 | " " ....... | " .. | " |
| 332 | " | " " .. | Murchisonia bicincta. Hall.................. | 1 | " " ....... | " .. | " |
| 333 | " | " " .. | Pleurotomaria subconica. Hall................ | 1 | " " ....... | " .. | " |
| 334 | " | " " .. | ........................................ | 4 | " " ....... | " .. | " |
| 335 | " | " " .. | ........................................ | 1 | " " ....... | " .. | " |
| 336 | " | " " .. | ........................................ | 3 | " " ....... | " .. | " |
| 337 | " | " " .. | Bellerophon bilobatus. Sow................... | 2 | " " ....... | " .. | " |
| 338 | " | " " .. | Endoceras magniventrum. Hall .............. | 2 | Rochester, Olmsted Co.......... | " .. | N. H. Winchell, Whitcomb's Quarry. |
| 339 | 1872. | " " .. | ........................................ | 11 | " " ......... | " .. | N. H. Winchell, Whitcomb's Quarry. |
| 340 | " | " " .. | Isotelus gigas. Hall. Asaphus platycephalus. Stokes........................... | 1 | " " ......... | " .. | N. H. Winchell, Whitcomb's Quarry. |
| 341 | " | " " .. | Murchisonia bell'cincta. Hall.................. | 1 | Pettit's Mill, Mantorville........ | " .. | N. H. Winchell. |
| 342 | " | " " .. | Chaetetes petropolitanus. Pander............. | 3 | " " ........ | " .. | " |
| 343 | " | " " .. | Murchisonia subfusiformis. Hall ?............ | 1 | " " ........ | " .. | " |
| 344 | " | " " .. | Receptaculites occidentalis. Salter ?.......... | 2 | Sec. 16, Pleasant Grove, Olm. Co | " .. | " |
| 345 | " | " " .. | Strophomena filitexta. Hall. (Dorsal valve).... | 1 | " " " | " .. | " as described by Billings (i. e. changing the name of the valve.) |
| 346 | " | " " .. | ........................................ | 2 | Rochester, Olmsted Co.......... | " .. | N. H. Winchell. |
| 347 | " | " " .. | ........................................ | 1 | Sec. 16, Pleasant Grove, Olm. Co | " .. | " |
| 348 | " | " " .. | ........................................ | 2 | " " " | " .. | " |
| 349 | " | " " .. | Murchisonia bicincta. Hall.................... | 1 | " " " | " .. | " |
| 350 | " | " " .. | ........................................ | 2 | " " " | " .. | " |

## Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 31, 1876.—Continued.

| Serial No. | Obtained. | | Name. | Number of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 351 | Oct. 1872 | Geol. Surv. | ........ | 2 | Pettit's Mill | Trenton | N. H. Winchell. |
| 352 | " | " " | ........ | 1 | Pleasant Grove | " | " |
| 353 | " | " " | Strophomena deltoidea. Con. | 1 | St. Anthony | " | " |
| 354 | " | " " | Pleurotomaria umbilicata. Hall | 1 | Rochester, Olmsted Co | " | " |
| 355 | " | " " | Murchisonia bicincta. Hall | 1 | " | " | " |
| 356 | " | " " | ........ | 3 | Pleasant Grove | " | " |
| 357 | " | " " | Chaetetes Lycoperdon. Hall (or stenopora fibrosa. Gold.) | 4 | Pettit's Mill | " | " |
| 358 | " | " " | Slabs of Trenton (fossiliferous) | 10 | " " | " | " |
| 359 | " | " " | Receptaculites Oweni. Hall | 4 | Near Rochester, Olmsted Co. | Galena | " |
| 360 | " | " " | Has the same as 371, which may not be Strophomena | 1 | " " " | " | " |
| 361 | " | " " | Ambonychia bellistriata. Hall? | 1 | " " " | Trenton | " |
| 362 | " | " " | ........ | 1 | " " " | Galena | " |
| 363 | " | " " | Murchisonia bellicincta. Hall | 1 | " " " | " | " |
| 364 | " | " " | Petraia corniculum. Hall | 1 | " " " | " | " |
| 365 | " | " " | ........ | 1 | " " " | " | " |
| 366 | " | " " | Ambonychia? | 1 | " " " | " | " |
| 367 | " | " " | Isotelus gigas. DeKay. (Caudal shield.) | 1 | " " " | " | " |
| 368 | " | " " | Endoceras magniventrum. Hall | 1 | " " " | " | " |
| 369 | " | " " | Strophomena fluctuosa Bill | 1 | " " " | " | " |
| 370 | " | " " | Rhynchonella capax. Con | 8 | Finn's Glen, Minneapolis | Trenton | " |
| 371 | " | " " | Strophomena (tenuistriata? v. No. 204.) | 1 | Near Rochester, Olmsted Co. | Galena | " |
| 372 | " | " " | " " | 1 | " " " | " | " |
| 373 | " | " " | " " | 1 | " " " | " | " |
| 374 | " | " " | Orthis testudinaria. Dal. | 12 | St. Charles | Trenton | " |
| 375 | " | " " | Orthis testudinaria. Dal. Strophomena deltoidea. Con. Asaphus platycephalus. Rhynchonella bisulcata. Hall. | 1 | " " | " | " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | Number of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 376 | Oct. 1872... | Geol. Surv.... | ........................ | 1 | St. Charles....... ... | Trenton... | N. H. Winchell. |
| 377 | " " ... | " " .... | ........................ | 1 | " .......... | " ... | " " |
| 378 | " " ... | " " .... | Strophomena deltoidea. Con................ | 1 | " .......... | " ... | " " |
| 379 | " " ... | " " ... | ........................ | 1 | " .......... | " ... | " " |
| 380 | " " ... | " " .... | Atrypa reticularis................ | 1 | " ?.......... | " ... | " " |
| 381 | " " ... | " " ... | ........................ | 1 | " .......... | " ... | " " |
| 382 | " " ... | " " .... | ........................ | 8 | " .......... | " ... | " " Cast of the interior of the [convex valve. |
| 383 | " " ... | " " .... | Strophomena (sp. unidentifiable)(v. 391.) Graptolithus, Lingula. Strophomena, Orthis..... | 1 | Mantorville.......... | Galena .... | " " |
| 384 | " " ... | " " .... | Orthoceras? and Pentremites.? (v. Fauna Silurienne. p. 106, fig. 60)................ | 1 | " ........ | " .... | " " |
| 385 | " " ... | " " ... | Strophomena alternata. Con.............. | 1 | " .......... | " .... | " " may be alternistriata. Hall. |
| 386 | " " ... | " " .... | Graptolithus. sp. nov .............. | 1 | " .......... | " .... | " " |
| 387 | " " ... | " " .... | Strephomena sp.? .............. | 1 | " .......... | " .... | " " cast of the interior of [convex valve. |
| 388 | " " ... | " " .... | Fragment of trilobite shield?.............. | 1 | " .......... | " .... | " " |
| 389 | " " ... | " " .... | Strophomena sp.?.............. | 1 | " .......... | " .... | " " |
| 390 | " " ... | " " .... | ........................ | 1 | " .......... | Trenton.... | " " |
| 391 | " " ... | " " .... | Strophomena (sp. unidentifiable) (v. 383)....... | 1 | " .......... | Galena .... | " " |
| 392 | " " ... | " " .... | ........................ | 1 | " .......... | Trenton. .. | " " |
| 393 | " " ... | " " .... | Lingula sp.?.............. | 1 | " .......... | " ... | " " |
| 394 | " " ... | " " .... | Strophomena sp.? .............. | 1 | ..................... | Galena .... | " " |
| 395 | " " ... | " " .... | ........................ | 1 | Minneapolis..... .... | Trenton.... | " " |
| 396 | " 1875... | " " .... | Orthis subquadrata. Hall.............. | 1 | Spring Valley........ | Galena .... | " " |
| 397 | " 1871?.. | " " .... | Ammonites communis..... .... .......... | 1 | Paris Basin. Fr..... | Tertiary... | |
| 398 | " " ?.. | Dr. Stoneman.. | Orthoceras bilineatum. Hall.............. | 1 | Minneapolis......... | Trenton?.. | Records doubtful |
| 399 | " 1872... | W. D. Hurlburt | Caudal extremity of trilobite.......... | 1 | Trenton Falls, N. Y. | " ... | |
| 400 | " " ... | " " .. | Stenopora petropolitana. Pander. Or Chaetetes Lycoperdon. Hall. or Chaetetes petropolitanus. M. & W.............. | 1 | " " | " ... | |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 401 | 1874 | W. W. McNair | Cinnebar ore | 1 | California | ..... | From the New Almaden Mines. |
| 402 | Oct. 28, 1872 | J. W. Pomeroy | Native Copper | 3 | | ? | Probably from Lake Superior Mines. |
| 403 | " " | " | Copper Scoria | 1 | | | " " " |
| 404 | Jan. 10, 1873 | J. Clarence Bryant. | Fern Leaves | 3 | Illinois Coal Measures. | Coal Meas. | |
| 405 | | G. D. B. Bainbridge | Talc. (Soapstone.) | 1 | | | |
| 406 | 1872 | S. D. Haskin | Straparollus Minnesotensis. (Pl. II, figs. 12 & 13.) (v. Pal. N. Y., I, Pl. 3, fig. 1.) | 1 | Traverse Des Sioux, Jordan Sandstone. | Jordan | 32 feet from surface of ground, 20 feet from top of rock. |
| 407 | Jan. 6, 1875. | Burdett Thayer | Large Crystal of Quartz | 1 | | | |
| 408 | Oct. 1872 | Geological Survey. | Pseudomorph after Pyrites | 1 | Winona | L. Mag. | N. H. Winchell. |
| 409 | " | " " | Orthoceras junceum. Hall | 1 | St. Charles | Trenton | " |
| 410 | " | " " | | 1 | " | | " |
| 411 | Sept. 1875 | W. D. Hurlburt | Isotelus gigas. Hall. (Cast.) Asaphus. | 1 | | Trenton | M. W. Harrington. |
| 412 | Oct. " | Geological Survey. | Galena | 1 | Near Rochester | Galena | Found on the surface. |
| 413 | " " | " " | Surface bog-ore | 1 | " Mantorville | | " " |
| 414 | Sept. " | " " | Asaphus. sp. ? (Or Bathyurus.) | 1 | Rochester | Trenton | Presented by W. D. Hurlburt. |
| 415 | Oct. " | " " | Siliceous iron ore | 1 | 4 ms. N. W. Cannon Falls | Potsdam | N. H. Winchell. (At Valentine's. See Andreas' Map.) |
| 416 | Jan. 8, 1875 | James Hinton | " " | 1 | Quincy, Olmsted Co. | " | Obtained as a boulder at Quincy. It is magnetic and is known as "Loadstone." |
| 417 | July, 1873 | Geological Survey. | Cretaceous sandstone, with vegetation. | 1 | 8 miles below New Ulm. | Cretaceous. | Fritz' quarry. Left branch of Minn. R. |
| 418 | Aug. 1876 | " " | Siliceous iron ore | 4 | 4 miles w. Cannon Falls | Potsdam | N. H. Winchell. (At Valentine's. See Andreas' Map.) |
| 419 | Oct. 1872 | " " | Isotelus gigas. Hall. (Cast.) | 1 | Mantorville | Galena | Presented by Frank Wilson. |
| 420 | " | " " | Receptaculites ? | 1 | Near Rochester | " | N. H. Winchell. |
| 421 | " | " " | Isotelus gigas. Hall. | 1 | " " | " | " |
| 422 | " | " " | (Cast) | 1 | Mantorville | " | Presented by Frank Wilson. |
| 423 | " | " " | | 1 | Near Rochester | " | N. H. Winchell. |
| 424 | Apr. 1876 | J. A. Armstrong | Mountain Bank (Penn.) soft coal | 1 | | Coal Meas. | " |
| 425 | " | " | Briar Hill (Ohio) soft coal | 1 | | " | " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

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|---|---|---|---|---|---|---|---|
| 426 | April 1876 | A. J. Armstrong | Anthracite, Penn. Hard coal | 1 | Lehigh, Penn | Coal Meas. | N. H. Winchell. |
| 427 | " " | " " | Canton Shaft, Illinois. Soft coal | 1 | Canton, Ill. | " | " |
| 428 | Oct. 1875 | Geol. Surv. | Atrypa ? | 13 | Spring Valley | Galena ? | " |
| 429 | " " | " " | Orthis occidentalis. Hall | 1 | " " | Galena | " |
| 430 | " " | " " | Strophomena fluctuosa. Bill | 5 | " " | " | The specimens are smaller than stated by Billings. (Pal. Fos. p. 124.) |
| 431 | Sept. 1875 | " " | Murchisonia bicincta. Hall ? | 1 | Mantorville | " | M. W. Harrington. |
| 432 | Oct. 1872 | " " | Rhaphistoma lapicida. Salter ? | 2 | Rochester, Olmsted Co. | Trenton | N. H. Winchell |
| 433 | " 1875 | " " | ........ | 2 | Chatfield, Fillmore Co. | " | " |
| 434 | " 1872 | " " | Orthis testudinaria. Dal. Orthoceras, Strophomena deltoidea. Con. Cyrtoceras. Rhaphistoma lapicida. Sal.? Murchisonia. Isotelus gigas. Hall. Licahas sp. ? | 1 | Rochester, Olmsted Co. | " | " (Slab.) |
| 435 | " " | " " | Strophomena deltoidea. Con. Orthis testudinaria. Dal. Asaphus platycephalus. Lichas. ? Lingula quadrata. Eich | 1 | " " | " | " " |
| 436 | " " | " " | Atrypa recurvirostra. Hall | 5 | St.Charles, Winona Co. | " | " |
| 437 | " " | " " | ........ | .... | ........ | ........ | |
| 438 | " " | " " | Rhynchonella bisulcata. Hall | 1 | " " | " | " |
| 439 | " " | " " | Rhynchonella capax. Con | 1 | " " | " | " |
| 440 | " " | " " | Slab with Rhynchonella, Orthis and Strophomena | 1 | " " | " | " |
| 441 | Nov. 1876 | Centennial Exhibition. | Cannel Coal | 1 | Greenup Co., Ky. | Coal Meas. | N. H. Winchell, from the Kentucky Survey. |
| 442 | " " | " " | Itacolumite | 1 | Mariposa Co., Cal. | ........ | " Purchased of A. E. Foot. |
| 443 | " " | " " | Beryl | 1 | Ackworth, N. H. | ........ | " " " |
| 444 | " " | " " | Crystallized Brown Haematite | 4 | Stewart Co., W. Tenn. | ........ | " From Tenn. Commissioners |
| 445 | " " | " " | " " " | 1 | Brierfield, Ala. | ........ | " From S. W. Baird. |
| 446 | " " | " " | Haematite | 4 | ———Kentucky | ........ | " From Kentucky Survey. |
| 447 | " " | " " | Magnetic Oxide of Iron | 7 | Port Henry, N. Y. | ........ | " |
| 448 | " " | " " | Ochreous Brown Haematite | 1 | ———Pennsylvania | ........ | " From Penn. Commissioners |
| 449 | " " | " " | Crystals of Franklinite | 1 | Franklin, N. Y. | ........ | " Purchased of Geo. Kunz. |
| 450 | " " | " " | Sulphate of Strontia | 1 | Ontario | ........ | " From Geol. Surv. of Canada |

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|---|---|---|---|---|---|---|---|
| 451 | Oct. 1876 | Cent. Exp. | Apatite | 1 | Bedford, Ontario | | N. H. Winchell, Geol. Surv. of Canada. |
| 452 | " | " | Carbonate of Zinc | 1 | Union Co., Tenn | | " Tenn. Commissioners. |
| 453 | " | " | Albertite | 3 | Albert Co., N. B. | | " Geol. Surv. of Canada. P. 57, Canada Catalogue. |
| 454 | " | " | " | Indefi | Canada | | " Geol. Surv. of Canada. |
| 455 | " | " | Sapphire | 1 | Near Franklin, N. J | | " Purchased of Geo. F. Kunz. |
| 456 | " | " | Antimony Ore | 1 | Prince William, N. B. | | " Geol. Surv. of Canada. |
| 457 | " | " | Spathic Iron Ore | 1 | Sutherland's R., N. S | | " " " |
| 458 | " | " | Gmelinite, Natrolite and Datholite | 1 | Bergen Hill, N. J | | " Purchased of Geo. F. Kunz. |
| 459 | " | " | Magnetite | 1 | Crosby, Ont. | | " Geol. Surv. of Canada. |
| 460 | " | " | Fluor Spar coated with Pyrites | 1 | Thunder B., B A | | " Purchased of A. E. Foote. |
| 461 | " | " | Copper Pyrites in micaceous sandstone. | 2 | Alleghany Co., N. C. | | " |
| 462 | " | " | Coal. (Said to be nearly pure carbon) | 1 | Poplar Creek, E. Tenn | | " 7 ft. thick. |
| 463 | " | " | Magnetite | 3 | New Bed Mine, Port Henry, N.Y. | | " |
| 464 | " | " | Semi-Anthracite Coal | 1 | Rockwood, Tenn. | | " 104 ft. thick. |
| 465 | " | " | Ankerite (ferriferous dolomite) | 1 | Canada | | " Geol. Surv. of Canada. |
| 466 | " | " | Brier Hill Coal | 2 | Ohio | | " |
| 467 | " | " | Quartz Crystals | 4 | Herkimer Co., N. Y. | Calciferous | Purchased of Geo. F. Kunz. |
| 468 | " | Geol. Surv. | Crag | 1 | Banks of Crow R., Hennepin Co. | Drift | N. H. Winchell. |
| 469 | " | Cent. Exp. | Haematite and Magnetite | 1 | Hull, Ottawa | | Geol. Surv. of Canada. |
| 470 | " | " | Sulp. Baryta | 1 | Two Islands, N. S | | " " |
| 471 | " | " | Dolomite, with crystals of Magnetite and carb. of Manganese | 1 | Sutton, Quebec | | " " |
| 472 | " | " | Sussexite (containing Magnesia.) | 1 | Franklin, N. J. | | Geo. F. Kunz. |
| 473 | " | " | Amazon Stone (smaller crystals) | 5 | Pike's Peak, Col. | | Purchased of A. E. Foote. |
| 474 | " | " | Spinel | 1 | Orange Co., N. Y. Harvey Hill Mine | | " " |
| 475 | " | " | Veined Copper Ore | 2 | | | Geol. Surv. of Canada. See p. 29, No. 10. u. a B. Canada Cat. |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 1, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 476 | Nov. 1876 | Centen'l Exposition. | Chromic Iron ore | 1 | Bolton, Quebec | ........... | Geol. Surv. of Canada. |
| 477 | " | " " | Crysoprase. (Cut.) | 1 | S. Park, Col | ........... | A. E. Foote, cut at Oberstein, Ger. |
| 478 | " | " " | Agate. (Cut.) | 2 | " " | ........... | " " " " " |
| 479 | " | " " | Black Agate. (Cut.) | 1 | " " | ........... | " " " " " |
| 480 | " | " " | Moss Agate. (Cut.) | 2 | " " | ........... | " " " " " |
| 481 | " | " " | Cuprite on Copper | 1 | England | ........... | " " |
| 482 | " | " " | Native Copper | 1 | Lake Superior | ........... | " " |
| 483 | " | " " | Embolite | 1 | Silver City, N. Mexico | ........... | " " |
| 484 | " | " " | Rutile | 1 | Georgia | ........... | " " |
| 485 | " | " " | Celestite and Sulphur | 1 | Sicily | ........... | " " |
| 486 | " | " " | Orthoclace. Amazon Stone | 3 | Pike's Peak, Col | ........... | " " |
| 487 | " | " " | Milky Quartz | 1 | Lake Superior | ........... | " " |
| 488 | " | " " | Ruby | 3 | Near Franklin, N. J | ........... | Geo. F. Kunz. |
| 489 | " | " " | Amethyst | 1 | Amethyst Harbor, L. Sup | ........... | N. H. Winchell, Geol. Surv. of Canada. |
| 490 | " | " " | Calymene Senaria. (Trilobite.) | 1 | Warren Co., Ohio | ........... | A. E. Foote. |
| 491 | " | " " | Azurite | 1 | Chesse, France | ........... | " " |
| 492 | " | " " | Bornite | 1 | Mt. Catine, Tuscany | ........... | " " |
| 493 | " | " " | Smoky Quartz, Cairngorm Stone and Smoky Topaz | 1 | Pike's Peak, Col | ........... | " " |
| 494 | " | " " | Saponite, *var.* Agalmatalite | 1 | Cherokee Co., N. C | ........... | " " |
| 495 | " | " " | Wavellite | 1 | Montgomery Co., Ark | ........... | " " |
| 496 | " | " " | Fossiliferous Iron ore | 2 | Pilot Knob, McMun Co., E. Tenn. | ........... | Gen. Wilder. |
| 497 | " | " " | Magnetite | 1 | Chattanooga, Tenn | ........... | " " |
| 498 | " | " " | Brown Haematite | 7 | " " | ........... | " " |
| 499 | 1875 | Prof. Laing | Sulphuret of Copper | 1 | Bolton, Quebec | ........... | |
| 500 | " | " | Plumbago | 1 | Canada West | ........... | |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 501 | 1875 | Prof. Laing | Asbestos | | South Stokely, Quebec | | |
| 502 | " | " | Concretions | 3 | N. W. Iowa | | |
| 503 | " | " | Galena ore | 1 | Galena, Ill | | |
| 504 | " | " | Calcite | 1 | Brompton, Quebec | | |
| 505 | " | " | Copper (native) | 3 | Lake Superior | | |
| 506 | " | " | Coral | 1 | | | |
| 507 | " | " | " | 1 | | | |
| 508 | " | " | " | 2 | | | |
| 509 | " | " | " | 1 | | | |
| 510 | " | " | Chaetetes sp.? Coral | 1 | | | |
| 511 | " | " | Petraia sp.? " | 1 | | | |
| 512 | " | " | Coral | 1 | | | |
| 513 | " | " | Pleurotomaria umbilicata. Hall | 1 | | | |
| 514 | " | " | Fragment of a crinoid stem | 1 | | | |
| 515 | " | " | Spirifer sp.? | 1 | | | |
| 516 | " | " | Fragment of a crustacean | 1 | | | |
| 517 | " | " | Iron ores | 4 | | | |
| 518 | " | " | | 1 | | | |
| 519 | " | " | Volcanic products | 2 | Sandwich Islands | | |
| 520 | 1871 | D. A. Roe | Greenstone, veined with epidote | 1 | St. Croix Falls | Igneous | D. A. Roe. |
| 521 | " | " | Porphyritic Greenstone | 1 | " " | " | D. A. Roe. |
| 522 | " | " | Porphyry (Red crystals of Feldspar) | 2 | " " | " | " |
| 523 | " | " | Epidotic Rock | 1 | " " | " | " |
| 524 | " | " | Greenstone | 1 | " " | " | " |
| 525 | 1873 | I. J. Rochussen | Cathnite (cut in form of a book) | 1 | Pipestone Quarry | Potsdam | " |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 526 | 1871 ? | ? | Claystones | 10 | Massachusetts | | ? |
| 527 | " | ? | Drusy Quartz | 1 | ? | | ? |
| 528 | 1873 | Geol. Surv. | Quartzite polished by blown sand | 3 | Pipestone Co., Minn. | Potsdam. | I. J. Rochussen. |
| 529 | 1871 ? | ? | Geode with Chalcedony lining | 2 | Keokuk, Iowa | Sub. Carb. | ? |
| 530 | 1873 | Geol. Surv. | Quartzite. (Red) | 1 | Pipestone Co., Minn. | Potsdam. | I. J. Rochussen. |
| 531 | 1871 ? | ? | Geode lined with quartz crystals | 1 | Brown Co., Ill. | Sub. Carb | ? |
| 532 | " | ? | Carb. Lime. Stalactitic. | 7 | Dubuque, Iowa | Galena. | ? |
| 533 | " | D. A. Roe | Wulfenite. (Molybdate of lead) | 1 | Southampton, Mass. | | |
| 534 | " | ? | Albite | 1 | Mass. | | No records. |
| 535 | " | ? | Pyritiferous mica schist ? | 1 | New Hampshire | | " |
| 536 | " | ? | Actinolite | 1 | Mass. | | |
| 537 | 1876 | Minneapolis boulder. | Labradorite | 4 | Minneapolis | Drift. | N. H. Winchell. |
| 538 | 1871 ? | ? | Hornblende | 1 | Chester, Mass. | | ? |
| 539 | " | ? | Micaceous feldspar. | 1 | ? | | ? |
| 540 | " | ? | Chrysocolla | 2 | Arizona. | | ? |
| 541 | " | ? | Beryl | 1 | Ackworth, N. H | | ? |
| 542 | " | ? | Tremolite (or Calamite) | 1 | Canaan, Conn. | | ? |
| 543 | " | ? | Andalusite (Macle) | 5 | ? | | ? See Dana's Min. p. 371, No. 323. |
| 544 | " | ? | Titanite (or yellow sphene) | 1 | Williams Bridge, N. Y. | | ? |
| 545 | " | ? | Topaz | 5 | Brazil, S. A. | | ? |
| 546 | " | ? | Kyanite | 2 | New Hampshire | | ? |
| 547 | " | ? | Tourmaline | 1 | New York | | ? |
| 548 | " | ? | Crag. | 1 | ? | | ? |
| 549 | " | ? | Tourmaline | 2 | Ackworth, N. H | | ? Massive. |
| 550 | " | ? | Amanthus | 4 | ? | | ? |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 13, 1876.*—Continued.

| Serial No. | Obtained. | | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 551 | 1871 ?...... | Prof. Beardsley.. | Hornblende. (Amphibole.)........ | 1 | Chester, Mass......... | .......... | ? |
| 552 | " ....... | ? ............ | Amphibole. (Asbestos.)...... | 1 | Bex, Switzerland....... | .......... | |
| 553 | " ....... | ? ........ .. | Chabazite. ........ | 1 | William's Bridge, N. Y. | .......... | ? |
| 554 | " ....... | ? ............ | Muscovite........ | 2 | ? ............ | .......... | ? |
| 555 | " ...... | Prof. Beardsley.. | Serpentine........ | 1 | New Hampshire ........ | .......... | ? |
| 556 | March, 1876 | Univ. Laboratory | Delessite ........ | 1 | Minneapolis ........ | .......... | N. H. Winchell. (In a boulder ) |
| 557 | 1871 ?..... | ? ...... | Talc........ | 1 | Massachusetts ........ | .......... | ? |
| 558 | " ...... | ? ........ | Garnet, Muscovite and Quartz.... | 1 | ? ............ | .......... | ? [air register frame. |
| 559 | " ...... | ................ | Steatite. (Soapstone.)........ | 3 | Minneapolis, (Found at) | .......... | Probably the fragment of a but |
| 560 | " ...... | D. A. Roe........ | Apatite........ | 1 | Burgess, Canada ........ | .......... | Terminated Crystal. |
| 561 | " ...... | ? ........... | Native Sulphur..... | 1 | Sicily ........ | .......... | ? |
| 562 | " ...... | ? .... ..... | Graphite........ | 3 | Ticonderoga, N. Y....... | .......... | ? |
| 563 | " ...... | D. A. Roe.... ... | Molybdenite........ | 1 | Westmoreland, N. H.... | .......... | ? |
| 564 | " ...... | ? ........... | Sphalenite. (Zinc-blende.)........ | 1 | England........ | .......... | ? |
| 565 | " ...... | ? ........... | Sphalenite. (Zinc-blende.)........ | 1 | Brown Co., Ill ... ..... | .......... | ? |
| 566 | " ...... | ? .... ..... | Fluorite........ | 2 | ? .... ........ | .......... | ? Massive. |
| 567 | 1876 ...... | W. E. Leonard... | Sal Ammoniac........ | 1 | ? ............ | .......... | ? |
| 568 | 1871 ?...... | D. A. Roe........ | Zincite and Franklinite........ | 1 | Franklin, N. J....... .... | .......... | ? |
| 569 | " ...... | ? ........... | Rose Quartz........ | 1 | Connecticut........ | .......... | ? |
| 570 | " ...... | ? ........... | Haematite. (And specula iron )........ | 1 | Cumberland, Eng..... | .......... | ? |
| 571 | Feb. 1872, | Dr. McMasters.. | Itacolumite ........ | 1 | Danbury, N. C... .... | .......... | |
| 572 | 1873 .. .... | I J Rochussen.. | Conglomerate ........ | 1 | Pipestone Co., Minn.. | Potsdam... | I. J. Rochussen. |
| 573 | 1874 .. .... | Geol. Surv...... | Agatized wood........ | 1 | Dakota........ | .......... | N. H. Winchell. |
| 574 | 1871....... | ? ........... | Sandstone........ | 1 | Pictured Rocks, McGregor, Iowa....... ..... | St. Peter... | |
| 575 | 1871....... | ? ........ | Barite ........ | 1 | Cheshire, Conn..... ... | .......... | ? |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 1, 1876.*—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | Number of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 576 | 1875 | N. H. Winchell | Gypsum | 2 | Grand Rapids | Carb. | ? (Cut.) |
| 577 | 1871? | ? | Satin Spar. (Selenite.) | 1 | ? | | ? |
| 578 | 1874 | N. H. Winchell | Calcite—Fibrous, dark | 1 | Dakota | Cretac. | N. H. Winchell. |
| 579 | 1871? | ? | Geode with lining of Calcite | Fragments. | Brown Co., Ill. | Carb | ? |
| 580 | " | ? | Cannel Coal | 3 | Fort Dodge, Iowa | " | ? |
| 581 | " | ? | Magnetite | 2 | Pilot Knob, Mo. | | ? |
| 582 | " | ? | "Diaspore, white. Rutile, red. Biotite, laminated, (also iron and emery.") | 1 | Mass. | | ? |
| 583 | 1876 | Cent'l Exposition | Gothite | 1 | Pike's Peak, Col. | | A. E. Foote. (Dealer.) |
| 584 | Oct. 1875 | Geol. Surv. | Red Granite | 1 | St. Cloud, Minn. | | N. H. Winchell. |
| 585 | 1871? | ? | Brown Haematite | 1 | ? | | ? |
| 586 | 1873 | Geol. Surv. | Catlinite | 1 | Pipestone Co., Minn. | Potsdam. | I. J. Rochussen. |
| 587 | 1871? | ? | Malachite | 1 | Plattville, Wis. | | ? |
| 588 | " | ? | Tourmaline. (black) | 1 | Ackworth, N. H. | | ? |
| 589 | 1874 | Geol. Surv. | Phonolyte | 1 | Bear Butte, Dakota | Igneous. | N. H. Winchell. |
| 590 | 1871? | ? | Agate. (Cut.) | 1 | Brazil, S. A. | | ? |
| 591 | " | ? | Quartz and Tourmaline | 1 | Ackworth, N. H. | | ? |
| 592 | 1872 | Geol. Surv. | Honestone. (Sawed.) | 1 | Austin, Minn. | Cretaceous. | N. H. Winchell. |
| 593 | Mar. 7. 1876 | " " | Barite coated with limonite after pyrite | 1 | Missouri | | |
| 594 | Nov. 1872 | " " | Ripple marked slab of red sandstone | 2 | New Ulm, Minn. | Potsdam. | N. H. Winchell. |
| 595 | 1871? | ? | Geode with lining of calc spar | 1 | Keokuk, Iowa | Carb. | |
| 596 | " | D. A. Roe | Greenstone porphyritic with feldspar and epidote | 1 | St. Croix Falls, Minn. | Igneous. | D. A. Roe. |
| 597 | " | ? | Pyrite, Galenite and calcite, on siliceous slate. | 1 | ? | | ? |
| 598 | 1873 | Geol. Surv. (Manufacturers.) | Fire Brick | 1 | New Ulm, Minn. | | N. H. Winchell. |
| 599 | Feb. 21, 1876 | W. D. Hurlburt | Cuprite and Malachite on Native Copper | 1 | Rochester, " | Drift. | On the bench of the Shakopee limestone other pieces weighed 6 pounds each. |
| 600 | Nov. 1876 | Cent'l Exposition | Brookite. (Crystals.) | 5 | Magnet Cove, Ark. | | A. E. Foote. |

*Catalogue of the Geological and Mineralogical Specimens of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 601 | Nov. 1876.. | Centennial Exposition. | Staurolite crystals | 2 | Mink Point, N. H | | A. E. Foote. |
| 602 | " .. | " " | Fluorite " | 1 | Cumberland, Eng | | " |
| 603 | " .. | " " | Siderite on Fluorite crystals | 1 | " | | " |
| 604 | " .. | " " | Chrysocolla | 1 | Mammoth Cave, Utah | | " |
| 605 | " .. | " " | "Hallite" " | 3 | Near Chester, Mass | | " |
| 606 | " .. | " " | Tourmaline " | 1 | Warwick, Mass | | " |
| 607 | " .. | " " | Manganite " | 1 | Ilefeld, Hartz Mts | | " |
| 608 | " .. | " " | Celestite | 1 | Pt. aux Peaux, Mich | | " |
| 609 | " .. | " " | Picrolite (serpentine) | 1 | Bohemia | | " |
| 610 | " .. | " " | Penninite | 1 | Lancaster Co., Penn | | " |
| 611 | " .. | " " | Baltimorite (serpentine) | 1 | Texas, " | | " |
| 612 | " .. | " " | Celestite | 1 | Ft. Dodge, Iowa | | " |
| 613 | " .. | " " | Stilbite (crystals) | 1 | Nova Scotia | | " |
| 614 | " . | " " | Perofskite " | 4 | Magnet Cove, Ark | | " |
| 615 | " .. | " " | Scolecite (zeolite) | 1 | Cape Blomidon, N. S | | " |
| 616 | " .. | " " | Lazulite (crystals) | 1 | Grass Mt., Ga | | " |
| 617 | " .. | " " | Tourmaline | 1 | Goveneur, N. Y | | " |
| 618 | 1871?. .... | ? | Quartz, mass of crystals | 1 | ? | | ? |
| 619 | Dec.31, 1875 | Geo. N. Bennett | Marbleized Slate | 1 | Hydeville, Vt | | Marbleized at Troy, N. Y. |
| 620 | 1871? | ? | Geode, with quartz lining | 2 | Brown Co., Ill | | |
| 621 | Dec. 1876 .. | S. F. Peckham | Bowenite (serpentine) | 1 | Smithfield, R. I | | |
| 622 | " .. | " | Vermiculite (Phyroselerite) | 1 | Milbury, Mass | | |
| 623 | " .. | " | Metamorphic limerock | 1 | Rhode Island | | Clouded. |
| 624 | " .. | " | Garnets in Mica schist | 1 | Chesterfield, Mass | | |
| 625 | " .. | " | Lepidolite | 1 | Paris, Maine | | |

*Catalogue of the Geological and Mineralogical Specimen of the Museum, to December* 31, 1876.—Continued.

| Serial No. | Obtained. | | Name. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 626 | Dec. 1876 | S. F. Peckham......... | "Gothite." (Haematite mostly)..... | 1 | Michigan Mine, Marquette, Mich.. | Huronian.... | |
| 627 | " " | " ..... .. | Phorphyritic iron, containing Titanium........................ | 1 | Cumberland Hill, R. I .............. | .... ... .... | |
| 628 | " " | " ........ | Phyllite................................ | 1 | Cranston, R. I....................... | ..... ........ | |
| 629 | " " | " ........ | Ripidolite............................. | 1 | Cumberland Hill, R. I............. | .............. | |
| 630 | " " | " ........ | Chalcopyrite........................ | 1 | " " ....... ..... | .............. | |
| 631 | " " | " ........ | Orthite (allanite) small, dark crystals. Scapolite (Wernerite) white, main portion. Sphene (Titanite) greenish massive........... ............ | 1 | Bolton, Mass............... ...... | .............. | |
| 632 | Dec. 1874 | " ........ | Slab of slate with impressions of plants.................................. | 1 | Portsmouth Mine, Rhode Island I. ............... | Carb......... | |
| 633 | ? ...... | ? .................. | Plumbago.......... ..... ........... | Many | Ticonderoga, N Y.................. | ..... ........ | |
| 634 | Nov. 1876 | Centennial Exposition. | Native sulphur................ .... | 1 | Kilauea, Sandwich Islands........ | .............. | |

# X.

# ORNITHOLOGICAL NOTES.

*By C. L. Herrick.*

MINNEAPOLIS, Dec., 1876.

*Prof. Winchell:*

The work represented by the following list of birds was, of course, much impeded by the difficulties incident to the season during which it was prosecuted; for not only are there comparatively few birds, and those of the commonest species to be found during the heated term, but those actually collected are often unfit, on account of the summer moult, for preservation or study.

Yet though the field work was over before the fall migration was fairly commenced, a few facts of some interest were noticed.

From observations made during the summer it would seem that the Brotherly-Love Vireo (*Vireo philadelphicus*) is not as rare as until recently supposed, and, indeed, it may be found to be quite as common in this locality as the *Vireo gilvus*. The vireos collected were shot without discrimination, yet two were quite typical specimens of *philadelphicus*.

The results obtained from the study of the few shrikes as yet collected at Minneapolis are so unexpected and withal so contradictory, that the following remarks are given with some hesitancy, especially as they are at variance with what has been written upon these birds by others who have collected in this State.

The Great Northern Shrike, or *Collurio borealis*, is as yet only noted as occurring during Spring and Fall. I have never heard of the nest in this vicinity. I am led to believe that the bird is somewhat rare, even during the migrations, for in the Spring it is very conspicuous from the habit it has of perching on a high tree and uttering at intervals its peculiar metallic cry on its arrival in any

locality; and thus the comparatively small number of specimens collected is more significant.

The smaller shrikes, so abundant here, or many of them, seem to partake of the characteristics of both varieties, viz: *ludovicianus* and *excubitoroides*. The three in the museum seem to me to nearly accord with the descriptions of *ludovicianus*. They all, together with two in my own collection, have the two inner tail feathers black to the bases; but another, which also possesses several other resemblances to *excubitoroides*, has evident white patches on all the tail quills. Again a number of these birds in the possession of Mr. T. S. Roberts agree in disagreeing with every description of either variety.

I draw from these facts the inference that the variety *ludovicianus* predominates over the other, but that the types are mingled and blended so as to baffle any accurate identification.

The nesting of these birds may be easily observed in many parts of the suburbs, but the nests are often mistaken for those of the more northern Butcher Bird.

Perhaps the Red-bellied Nuthatch may be less rare during migration than supposed, if searched for in suitable localities.

The bird-fauna of the State has received one addition in the tern *Sterna caspia* (Thalassus c. Boie.) This is the largest of the terns, and is a very beautiful and striking bird. The only specimen as yet identified from this State, as far as I am aware, was secured at Long Lake by Will Secombe, of Minneapolis, by whom it was presented to the museum.

The English House-Sparrow was simultaneously observed by Mr. Roberts and myself during the early part of the winter about the streets of the city, and I learn from that observer that they have survived our severe weather as yet.

The fact that birds are often infested by intestinal worms particularly the Tape Worm, (Tænia) has attracted so much notice of late that I mention the collection of a variety of these parasites from the solitary Tattler; also a quasi-parasitic colony of crustaceans found upon a goose. I received from Mr. Roberts several specimens of crustaceans collected from Hutchins' goose, found deeply imbedded in the feathers near the skin. These proved to be miniature Sand Fleas (fresh water.) Of course it is hardly to be supposed that this was more than an accident. I cannot account for this except by supposing it to be the result of the proclivity of these fleas (so often noticed) to wedge themselves in the thick masses of leaves upon the Bladder-wort and other water plants.

# AVES.

*Note.* A star (*) signifies male. A dagger (†) denotes the female.

### TURDIDÆ.

1. Harpochynchus rufus. Cab. Brown Thrush. Minneapolis, Aug. 20th, 1876. (69.)
2. Mimus carolinensis. Cab. Cat Bird.* Minneapolis, May 14th, 1875. (26.)

### SITTIDÆ.

3. Sitta carolinensis. Gm. White-Bellied Nuthatch.* Minneapolis, Aug. 12th, 1876. (64.)
4. Sitta carolinensis, Gm. White-Bellied Nuthatch. Minneapolis, July 24th, 1876. (65.)
5. Sitta canadensis, L. Red-Bellied Nuthatch. Minneapolis, Aug. 16th, 1876. (66.) *Not common.*

### SYLVICOLIDÆ.

6. Mniotilla varia. Vieill. Black and White Creeper.* Minneapolis, Aug. 16th, 1876. (10.)
7. Mniotilla varia. Vieill. Black and White Creeper. Minneapolis, Aug. 18th, 1876. (77.)
8. Dendrœca æstiva. Bd. Golden Warbler. Minneapolis, May 7th, 1875. (6.)
9. Dendrœca æstiva. Bd. Golden Warbler.* Minneapolis, Aug. 16th, 1876. (7.)
10. Dendrœca æstiva. Bd. Golden Warbler.* Minneapolis, Aug. 14th, 1876. (8.)
11. Dendrœca coronata. Gray. Yellow-Rumped Warbler.† Minneapolis, May 15th, 1875. (9.)
12. Mniotilla varia. Vieill. Black and White Creeper. Minneapolis, Aug. 18th, 1876. (76.)

13. Seiurus aurocapillus. Sw. Golden-Crowned Thrush.* Minneapolis, Aug. 20th, 1876. (79.)
14. Seiurus aurocapillus. Sw. Golden-Crowned Thrush. Minneapolis, May 15th, 1875. (4.)
15. Seiurus novembraeinsis. Nutt. Water Thrush. Lake Minnetonka, Aug. 14th, 1876. (5.)
16. Setophaga ruticilla. Sw. Red Start.* Minneapolis, Aug. 20th, 1876. (80.)
17. Setophaga ruticilla. Sw. Red Start.* Minneapolis, Aug. 20th, 1876. (81.)
18. Setophaga ruticilla. Sw. Red Start. Minneapolis, Aug. 15th. (15.)

TANAGRIDÆ.

19. Pyranga rubra. Vieill. Scarlet Tanager.* Minneapolis, July 19th, 1876. (28.)

HIRUNDINIDÆ.

20. Cotyle riparia. Boie. Bank Swallow.* Minneapolis, Aug. 14th, 1876. (47.)

AMPELIDÆ.

21. Ampelis cedrorum. Bd. Cedar Bird.* Minneapolis, July, 1876. (25.)

VIREODINÆ.

22. Vireo olivacea. L. Red-eyed Vireo.* Minneapolis, July 19th, 1876. (11.)
23. Vireo phillidelphica. Cassin. Phillidelphia Vireo. Minneapolis, Aug. 1876. (14.)
24. Vireo phillidelphica. Cassin. Phillidelphia Vireo. Minneapolis, Aug. 20th, 1876. (78.)
25. Vireo gilva. Cass. Warbling Vireo.* Minneapolis, July 11th, 1876. (12.)
26. Vireo flavifrons. Bd. Yellow-throated Vireo.* Minneapolis, Aug. 16th, 1876. (13.)

LANIDÆ.

27. Collurio ludivicianus. Bd. Loggerhead Shrike.* Minneapolis, Aug., 1876. (7.)
28. Collurio ludivicianus. Bd. Loggerhead Shrike.† Minneapolis, July 20th, 1876. (2.)
29. Collurio ludivicianus. Bd. Loggerhead Shrike. Minneapolis, 1875. (3.)

FRINGILLIDÆ.

30. Chrysomitris tristis. Bon. Yellow Bird.† Minneapolis, Nov. 26th, 1875. (31.)
31. Chrysomitris tristis. Bon. Yellow Bird.* Champlin, Minn., June 18th, 1875. (30.)
32. Plectrophanes nivalis. Meyer. Snow Bunting.* Minneapolis, Nov. 30th, 1876. (88.)
33. Plectrophanes nivalis. Meyer. Snow Bunting.† Minneapolis, Nov. 30th, 1876. (89.)
34. Poœcetes gramineus. Bd. Grass Finch. Minneapolis, Aug. 16th, 1876. (35.)
35. Poœcetes gramineus. Bd. Grass Finch. Minneapolis, Aug. 1876. (36.)
36. Spizella socialis. Bon. Chipping Sparrow.* Minneapolis, Aug. 14th, 1876. (32.)
37. Spizella monticolor. Bd. Tree Sparrow.* Minneapolis, Oct. 9th, 1876. (84.)
38. Spizella pallida. Bon. Clay-Colored Bunting.* Minneapolis, Aug., 1876. (33.)
39. Spizella pallida. Bon. Clay-Colored Bunting.† Minneapolis, May 7th, 1875. (34.)
40. Chondestes grammaca. Bon. Lark Finch. Minneapolis, 1875. (38.)
41. Melospiza melodia. Bd. Song Sparrow.* Minneapolis, Aug. 12th, 1876. (37.)
42. Goniaphea ludiviciana. Bowdich. Rose-Breasted Grosbeak.* Minneapolis, June, 1875. (27.)
43. Coniaphea ludiviciana. Bow. Rose-Breasted Grosbeak. Minneapolis, Aug. 18th, 1876. (75.)
44. Cyanospiza cyanea. Bd. Indigo Bird.* Minneapolis, July, 1876. (29.)
45. Pipilo crythrophthalmus. Vieill. Chewink.* Minneapolis, Aug. 3d, 1876. (39.)
46. Junco hyemalis. Sd. Snow Bird.* Minneapolis, Oct. 9th, 1876. (83.)

ISTERIDÆ.

47. Dolichonyx oryzivorus. Sw. Bobolink.* Minneapolis, July 20th, 1876. (42.)
48. Agelæus phœnicus. V. Red-Winged Black Bird.* Minneapolis, Aug. 4th, 1876. (41.)
49. Sturnella magna. Sw. Meadow Lark.* Minneapolis, July 18th, 1876. (40.)
50. Ieterus baltimore. Daudin. Baltimore Oriole.* Minneapolis, May 22d, 1875. (21.)
51. Ieterus spurius. Bon. Orchard Oriole.* Minneapolis, 1875. (22.)
52. Ieterus spurius. Bon. Orchard Oriole.* Minneapolis, 1875. *Juv. specimine.* (23.)

53. Icterus spurius. Bon. Orchard Oriole.† Minneapolis, July, 1876. (24.)

CORVIDÆ.

54. Corvus corax. L. Raven.* (*Mounted.*) Minneapolis, Oct., 1876. (85.) *Not common.*
*Presented by N. Herrick, Esq.*

55. Cyanurus cristatus. Sw. Blue Jay. Minneapolis, July 20th, 1876. (45.)

TYRANNIDÆ.

56. Tyrannus carolinensis. Bd. King Bird.* Minneapolis, May 14th, 1875. (20.)

57. Contonops virens. Cab. Wood Pewee.* Minneapolis, Aug. 11th, 1876. (16.)

58. C. virens. Cab. Wood Pewee.* Minneapolis, Aug. 15th, 1876. (17.)

59. C. virens. Cab. Wood Pewee.† Minneapolis, Aug. 15th, 1876. (18.)

60. C. virens. Cab. Wood Pewee. Minneapolis, July, 1876. (19.)

CAPRIMULGIDÆ.

61. Chordeiles virginianus. Bon. Night Hawk.* Minneapolis, Aug. 16th, 1876. (44.)

CYPSELIDÆ.

62. Cotyle pelasgio. Bd. Chimney Swift.* Minneapolis, July 10th, 1876. (43.)

ALCEDINIDÆ.

63. Cryle alcyon. Boie. Belted Kingfisher. Minneapolis, Aug. 1st, 1876. (46.)

PICIDÆ.

64. Picus pubescens. L. Downy Woodpecker.* Minneapolis, July, 1876. (60.)

65. Picus pubescens. L. Downy Woodpecker.* Minneapolis, Aug. 16th, 1876. (61.)

66. Picus pubescens. L. Downy Woodpecker.* Minneapolis, Aug. 20th, 1876. (73.)

67. Melanerpes erythrocephalus. Sw. Red-headed Woodpecker. July 23d, 1876. (62.)

68. Melanerpes erythrocephalus. Sw. Red-headed Woodpecker.* Minneapolis, Aug. 28th. (71.)

69. Colaptes auratus. Sw. Golden-winged Woodpecker. Minneapolis, April 29th, 1875. (63.)

70. Colaptes auratus. Sw. Golden-winged Woodpecker.* Minneapolis, Aug. 28th, 1876. (72.)

STRIGIDÆ.

71. Bubo virginianus. Wilk. Great-horned Owl.* Minneapolis, Nov., 1876. (86.) *From Collection of C. L. Herrick.*

FALCONIDÆ.

72. Falco sparverius. L. Sparrow Hawk. Minneapolis, Aug. 2, 1876. (67.)
73. Falco sparverius. L. Sparrow Hawk. Minneapolis, Aug. 13th, 1875. (68.)
74. Buteo borealis. Vieill. Red-tailed Hawk.* Jav. Minneapolis, July, 1876. (82.) (*Mounted.*)

COLUMBIDÆ.

75. Ectopistes migratorius. Sw. Wild Pigeon. Minneapolis, July 11th, 1876. (58.)
76. Ectopistes migratorius. S. Wild Pigeon. Minneapolis, July 11th, 1876. (59.)

TETRAONIDÆ.

77. Bonasa umbellus. Stephens. Ruffed Grouse. Minneapolis, July, 1876. (48.)

CHARADRIIDÆ.

78. Ægialitis vociferus. Cass. Killdeer Plover.† Minneapolis, July 22d, 1876. (57.)

SCOLOPACIDÆ.

79. Totanus solitarius. Wilson. Solitary Tattler.* Minneapolis, Aug. 17th, 1876. (55.)
80. Totanus solitarius. Wils. Solitary Tattler.* Minneapolis, Aug. 12th, 1876. (56.)
81. Totanus solitarius. Wils. Solitary Tattler. Minneapolis, Aug. 20th, 1876. (74.)
82. Tringoides macularius. Gray. Spotted Sandpiper. Minneapolis, Aug. 4th, 1876. (53.)
83. Tringoides macularius. Gray. Spotted Sandpiper.* Minneapolis, July 14th, 1876. (54.)
84. Actiturus bartramius. Bon. Upland Plover. Minneapolis, Aug. 6th, 1875. (52.)

ARDEIDÆ.

85. Botaurus mugitans. Coues. Bittern. Minneapolis, 1875. (49.)

RALLIDÆ.

86. Porzana carolina. V. Carolina Rail.† Minneapolis, Aug. 20th, 1876. (70.)

LARIDÆ.

87. Sterna caspia. Pall. Caspian Tern. Long Lake, Nov., 1876. (87.) *Rare.*
*Collected and presented by Will. Secombe.*

88. Hydrochelidon lariformis. Coues. Black Tern. Minneapolis, July 19th, 1876. (50.)

89. Hydrochelidon lariformis. Coues. Black Tern, *young*. Minneapolis, July 19th, 1876. (51.)

ANATIDÆ.

90. Bucephala clangula. Wils. Golden-Eye. Garrot. Minneapolis, Jan. 17th, 1877.

Just as this proof is going to press, I have the pleasure of announcing that I had the good fortune to secure for the collection two specimens of Le contes Sparrow, *coturniculus lecontei*, thus adding this to the very few localities of its occurrence. A more extended notice will doubtless be given hereafter.

# XI.

# A NEW CYCLOPS.

By C. L. Herrick.

*Cyclops quadricornis* has often been used as an object for study by those desirous of becoming familiar with the process of development in crustacea. For this it is eminently fitted both on account of its very distinct changes and its abundance in every pond and pool.

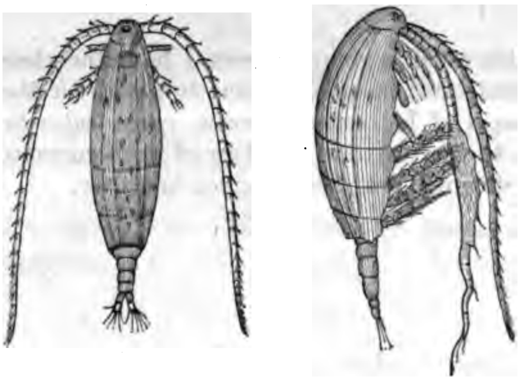

*Fig.* 1.

There is another member of the same genus which has not, apparently, been described, and I have therefore provisionally named it *C. longicornis* from the very long primary antennæ.

The appearance of an ordinary individual (*Fig.* 1.) is not very widely different from the ordinary species. But the first glance of the female with the spherical sac of ova under the abdomen makes the creature seem quite distinct.

The general appearance and its movements while swimming briskly about cause it to look like a magnified cladocera, the long

spreading antennæ increasing the similarity. The glass at once dispels the illusion however.

The eggs are larger in proportion than those of *quadricornis* and are loosely aggregated beneath the abdomen. The cephalothorax is very large and carries the usual complement of motory appendages. The first antennæ are long—exceeding the body. The second pair are specialized enough to be called antennæ, and the claws are, according to my observation, small though they were indistinctly seen.

The abdomen is in proportion smaller than in *quadricornis*, and the tail similar to that of a young of that species. Of internal structure little was made out, but the red glands are as prominent as in the other. A curious case of malformation of antennæ is shown in the figure. The color is transparent white, except the tips of the antennæ and the last segments of the abdomen.

The process of cephalization is well illustrated by the cyclops, though not as aptly as in the larger crustaceans, the Sand Fleas.

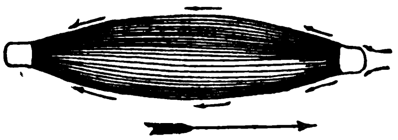

*Fig. 2.*

A recent observation of a number of diatoms dipped from the bottom of the deeper portion of Lake Calhoun, seems to prove that one species is clothed with cilia throughout, and not simply at the ends as usually described. While watching the motions of a Navicula-like plant propelling itself slowly along it was seen to collide with a large mass of vegetable matter, and while thus brought to a stand-still the infinitesimal particles floating near it were seen to traverse its whole length, the diatom and particles beyond reach of its influence remaining motionless in the meantime. This specimen was of sufficient length to preclude the possibility of the cilia at the ends having any influence upon the particles.

### *Other Collections.*

Besides the Moose mentioned in the report of last year, the following mounted mammals are on exhibition:

*Antilœapra Americana.* Ord. Pronghorn Antelope. 2 male and 2 female. Custer Expedition to the Black Hills. 1874.

*Corvus Canadensis.* Exl. American Elk. Custer Expedition to the Black Hills. 1874.

Badger. Custer Expedition to the Black Hills. 1874.

*Ursus horribilis.* Ord. Grizzly Bear, female. Custer Expedition to the Black Hills. 1874.

*Corvus lencurus.* Doug. White-Tailed Deer; 1 male, 2 females. Cus. Ex. Blk. Hills. 1874.

*Rangifer Caribou.* And. and Bach. Woodland Caribou (unmounted.) Presented Dec., 1875, by Nathan Butler.

*Sciurus hudsonius.* Pall. Red Squirrel. Three specimens.

*Tamius striatus.* Bd. Chipmunk.

*Spermophilus tridecemlineatus.* Mitch. Striped Gopher.

*Hesperomys michiganensis.* Wag. Michigan Mouse.

*Procyon lotoi.* Ston. Common Raccoon.

## *Reptiles.*

*Pana catesbiana.* Shaw. Bull Frog.

*Amblystoma tigrinum.* Bd. (Immature.) Common Salamander.

*Eutaenia radix.* Bd. & Gir. Garter snake.

## *Skeletons Mounted.*

*Podilymbus podiceps.* Lawr. Pied-billed Grebe.

*Botaurus mugitans.* Bart. Bittern.

# INDEX TO THE GEOLOGICAL REPORT.



31

## *ERRATA.*

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Page 5, line 4 from bottom, for "fossilliferous" read fossiliferous.

Page 130, line 14, *for* "There" read This.

Page 156, line 12 from bottom, for "nine" read eight.

Page 158, line 6, for "(gray hardpan to near the top of the bluff)." read (gray hardpan) to near the top of the bluff.

Page 179, strike out "This fall is forty or fifty feet high, divided in the middle by a rocky island of pyramidal form."

Page 220, line 10 from bottom, for "left branch" read left bank.

Page 230, strike out "X."

Page 238, strike out "XI."

On the map of the vicinity of the Falls of St. Anthony, under "*Explanation*," last line, strike out "Gray."

fm N. H. Winchell.
M 21, '78.

THE

# GEOLOGICAL

AND

# NATURAL HISTORY SURVEY

OF

# MINNESOTA.



## THE SIXTH ANNUAL REPORT

FOR THE YEAR 1877.

OFFICERS OF THE SURVEY:

| | |
|---|---|
| N. H. WINCHELL, State Geologist | In Charge. |
| S. F. PECKHAM, | Chemistry. |
| M. D. RHAME, | Topography. |
| P. L. HATCH, | Ornithology. |
| ALLEN WHITMAN, | Entomology. |
| CLARENCE L. HERRICK, | Laboratory Assistant. |


Submitted to the President of the University, May 25, 1878.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1878.

14747

THE

# GEOLOGICAL

*With the regards of*
*N. H. Winchell,*
*Minneapolis,*
*Minnesota.*

*University of Minn.*
[Please acknowledge]

FOR THE YEAR 1877.

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Submitted to the President of the University, May 25, 1878.

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MINNEAPOLIS:
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1878.

## THE BOARD OF REGENTS OF THE UNIVERSITY.

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# ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1877.

*To the President of the University :*

DEAR SIR—I have the honor to offer, and to transmit through you to the Board of Regents of the State University, the Annual Report required by law on the progress of Geological and Natural History Survey of the State, being the sixth since the beginning of the survey.

Very respectfully, your obedient servant,

N. H. WINCHELL.

STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

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1. *Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey. 34 pp., 1860. Reprint from the Wisconsin Reports for 1858. Out of print.*
2. *Statistics and History of the Production of Iron, by A. S. Hewitt. 47 pp., 1860. Reprint of a paper read before the American Geographical and Statistical Society, January 31, 1856. Out of print.*
3. *Report of Anderson and Clark, Commissioners on the Geology of the State, January 25, 1861. 8vo. 26 pp. Out of print.*
4. *Report of Hanchett and Clark, November, 1864. 8vo. 82 pp. Out of print.*
5. *Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior. 1866. 8vo. 23 pp.*
6. *Report of H. H. Eames on some of the northern and middle counties of Minnesota. 1866. 8vo. 58 pp. Out of print.*
7. *Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota. 1866. 8vo. 52 pp., close type, with wood cuts.*
8. *Report of N. C. D. Taylor on the Copper District of Kettle River, incorporating Mr. James Hall's estimate of the copper prospects of that district. 1866. 2 pp. 8vo. Found only in the Executive Documents.*
9. *Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June 17, 1871. 8vo. 26 pp.*
10. *The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp., with a colored geological map of the State. Published in the Regents' Report for 1872. Out of print.*
11. *The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 145 pp. 8vo.; with illustrations.*
12. *The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo., with two county maps. Published in the Regents' Report for 1874.*
13. *The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington. 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.*
14. *The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson; 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.*

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[NOTE.—Of the foregoing, Nos. 1, 2, 4 and 6 are wanted by the Survey.]

# REPORT.

## I.

### SUMMARY STATEMENT.

The Regents having authorized a joint examination with the State Board of Health of the water supply for domestic uses in the Red River valley, the first work undertaken in the season of 1877 was an attempt to ascertain the cause or causes of the unwholesome water often found in common wells throughout the valley of that river. About four weeks were spent in that part of the State, the observations extending from Breckenridge, the present terminus of the St. Paul & Pacific Railroad, to Winnipeg in Manitoba. The details and the results of this examination will be found in the following pages. It is sufficient here to say that the chief cause of the "stagnant," or foul water so common in wells of that part of the state was found to be the almost universal practice of curbing wells with pine wood; and that there is nothing in the water itself which is unwholesome or injurious. It is true that wells from the drift-clay are apt to be more or less alkaline, unless from extensive gravel or sand beds within the clay, but there is no reason, except artificial or unnatural causes, why the water of that part of the State should become foul or "stagnant" in common wells, any sooner or more frequently than in any other equally clayey portion of the northwest. It was found, indeed, later in the season, that this difficulty is by no means confined to the valley of the Red River of the North. It is encountered with equal frequency throughout the entire western half of the State, from the Iowa line northward to Manitoba, and must be referred to some cause that is not local in its application. In the absence of stone for walling their wells, the

early settlers of the prairies, who have been generally men of little pecuniary means, have resorted to the use of pine plank for curbing them, on account of its availability and cheapness, and to this practice may be attributed by far the greater portion of the difficulty resulting in many cases of sickness (usually typhoid fever) and many deaths. This fact cannot be too widely published, nor its pernicious effects on the general health and prosperity of the newly settled counties too strongly impressed on the people.

Reconnoissances into different parts of the state have been made during the season, having different objects in view, viz.: one into Wright county for the examination of localities of reputed "coal" outcrop; one into Rice county preparatory to the survey of the county by Prof. L. B. Sperry; one into Goodhue county preparatory to the full examination of that county during the coming season; one over the line of the Northern Pacific railroad supplementary to the water-examinations of the Red River valley earlier in the season, and for geological observations, and one into Morrison county for the purpose of preliminary geological observations. The results of these reconnoissances are given in the following report, so far as they can be made useful at the present stage of the survey.

In the survey of Hennepin county it was found necessary to embrace some parts of Ramsey, and during the past season the survey of that county was completed, and is herewith reported, with the usual maps and diagrams.

Rock and Pipestone counties, the most southwesterly in the State, have also been examined, and are reported in the same manner.

Rice county has also been surveyed in detail by Prof. L. B. Sperry of Northfield College, and his report on the same is herewith transmitted.

Further examination of the fossils of the Trenton was carried on during the intervals of interruption of the field-work, and some further notes on the same are given in the following pages. It cannot be expected, however, that while the field-work is steadily carried on the detailed laboratory work of palaeontology and lithology will progress with equal pace without the employment of extra assistance. Still such progress as is possible will be reported from time to time.

There is, accompanying this, a detailed report on the General Museum for the year 1877, showing the addition of minerals, and specimens of foreign rocks, as well as the naming of fossils in the cases of the Museum. There is work enough now on hand, in the Museum, to require the steady work of a man a whole year, with

nothing else to do. It cannot be impressed to strongly on the Regents that there is a necessity of employing more assistance, or of the curtailment of some of the labor now devolving on a single man. It is certainly very necessary that the Museum be placed in its best condition. This implies the working up of many boxes of material, both in mineralogy and lithology, and in palaeontology. This is nearly all within the purview of the geological survey of the State, the material being almost all the product of the field examinations, and would redound to its substantial progress perhaps to a greater extent than the continued and constant prosecution of the field-work.

The report of Prof. Peckham on the chemical analyses of various substances submitted in the progress of the field-work is also included in the following pages; also, that of Dr. P. L. Hatch on the investigations he has prosecuted during the year on the ornithology of the State.

The year has been signalized by the disappearance from the State, and from the entire Northwest, of the Rocky Mountain Locust. The interesting and important report of Mr. Whitman on the phenomena and causes of such disappearance, and on other insects injurious to farm products still existing within the borders of Minnesota, is also transmitted herewith.

In Botany, while there has been a steady increase of specimens, gathered by Mr. Herrick, or presented by other collectors, there has been no attempt at classification or thorough examination. The progress of the work in this field will be mainly in the gathering of material, for several years; but finally the aid of expert botanists will have to be obtained in the preparation of a final report.

The officers of the Northern Pacific and of the St. Paul & Duluth Railroads very courteously furnished the State Geologist with passes over their roads while engaged in the northern part of the State, and those of the St. Paul & Pacific and of the Red River Transportation Company extended the same favors during the progress of the survey of the Red River water supply.

A considerable portion of the season has been spent in the northern half of the State. What has been done there has been of the nature of hasty reconnoisances. Nothing else is possible. The means now available for the survey will not warrant the commencement of detailed surveys in a region mainly without roads and but sparsely inhabited, however great the need of geological examination. It is mainly for this reason that the survey has been carried on during the past six years in the southern portion, where, at much less expense, the utility of the survey could be demonstrated

and its progress be more evident: as it is well known that geological surveys have, in various states, come to unfortunate interruption, and sometimes final termination, for causes immediately political or economical. The time has come, however, when it will not be prudent nor just to further ignore the northern half of the State. An unusual impetus in immigration, and in prospective mining, has stirred the people in that part of the State, during the past year, to make serious demands for the services of the Geological Survey in exploring and developing their material resources. The enterprise of the government of the Dominion of Canada on our northern frontier, in the building of railroads and canals, will not fail to react powerfully on the State of Minnesota north of Lake Superior. The Canadian geologists have already visited and reported a number of times on the contiguous portions of the British Possessions. It seems to be very necessary to subject that part of the State to a thorough geological survey; but it will require expensive outfits for two or three exploring parties, and it would be several years before the survey could progress sufficiently to warrant a final report. Meantime, during the progress of the work in the northern part of the State, investigations should not be suspended in the southern portion. In order to carry on the survey now as it seems to be necessary, an additional sum of six or eight thousand dollars per annum, for about four years, should be available. It would then be possible, probably, to issue a couple of volumes of a final report, one on the southern palæozoic formations, and one on the metamorphic and azoic rocks of the northern portion of the State.

# II.

## THE WATER SUPPLY OF THE RED RIVER VALLEY.

The State law by which the survey is being carried on requires a complete account of the mineral and other waters of the State, including accurate chemical analyses. It was at the instance of the Secretary of the State Board of Health that the immediate examination of this region was undertaken; the sanitary questions involved being regarded of great importance. With a view to the co-operation of the Regents and the State Board of Health in this examination, a joint party was organized, consisting of the State Geologist, with Prof. S. F. Peckham on the part of the Regents, and Dr. C. N. Hewitt, Secretary of the Board of Health. The plan of procedure consisted in a descent of the valley from Breckenridge, on the St. Paul & Pacific Railroad, to Winnipeg, in Manitoba, stopping at the principally settled points for information concerning the objects of the survey, examining all accessible wells and procuring samples of water, and carefully noting the nature of the river bluffs. Subsequently, and during the further prosecution of the field-work over the western portion of the State during the season, more extended observations on the same subject were made by the State Geologist outside of the Red River valley, and the valley itself was again visited for further facts of comparison and verification. The conclusions arrived at in this report are based on all the facts observed; and as they vary somewhat from opinions advanced by other members of the party, it is but just to relieve them from all responsibility for them. Soon after the return of the party a summary of these conclusions was prepared at the instance of Gov. J. S. Pillsbury, and it was published in the *Pioneer Press* for September 18, 1877.

It is also necessary to state that the samples of water selected for analysis were not such as would test the correctness of these conclusions, nor that of any theory that has yet been advanced for the cause of the foul waters of the Red River valley. In order to determine something by chemical analyses of the waters, the writer selected and urged the full analysis of four samples only, with qualitative tests for other samples to show their relations to either of these, viz.:

1. Some simply alkaline water from a deep well.
2. Alkaline water from some deep well contaminated by organic decay.
3. Water from some shallow well uncontaminated by organic decay.
4. Water from a shallow well foul from organic decay.

The analysis of water from the following wells, conforming to the conditions required by the above varieties of water, was recommended for the purpose of arriving at some satisfactory result. It is to be hoped that the survey may be able at some future time to institute further examination, and chemical analysis, should the explanation here given not prove sufficient.

1. Water from the Brewery at Moorhead.
2. Town well at Breckenridge.
3. McHench's cistern well at Fargo.
4. Well at Mr. Sloggy's house (not the Bramble House.)

*The Facts Known Before the Survey.*

The flat prairie country generally, throughout the western portion of the State, has been much troubled by bad well water. This has been reported to the survey from Lyon, Renville, Redwood and Murray counties, in the southwestern portion of the State, and had by the parties troubled by bad water been attributed to a so-called "peculiar clay," a "blue clay," a "black clay," or to some other deposit in the drift which had been met with in the wells. Similar reports had come from the country further north, and latterly from the Red River valley specially. The settlement of the Red River valley has been rapidly going on during the past two years, and these difficulties were more numerously and urgently presented from that quarter of the State. As these waters had a very deleterious effect on the health of the people, and threatened to retard the development of that portion of the State, the State Board of Health very wisely initiated the systematic examination of the whole question which is now being made, but directed itself specifically to the valley of the Red River of the North. The waters

from the wells dug, whether deep or shallow, have been found to become foul, or "stagnant," sooner or later, and if their use has continued much beyond the discovery of this condition they have produced diarrhœa of a persistent nature, and finally typhoid fever. Some cases have terminated fatally. These facts were of occurrence on the line of the St. Paul & Pacific Railroad, at nearly all the stations west of the line of the Big Woods, even outside the valley of the Red River; on the Northern Pacific Railroad west of Detroit; along the same railroad in Dakota, and down the valley to Winnipeg. These effects were known also south of the Minnesota river, but they have not been attributed so directly, so far as the writer is aware, to the water used for domestic purposes. Yet typhoid fever and intestinal diseases have had, during the past ten or fifteen years, an area of greatest prevalence in western Minnesota and Iowa, according to the ninth United States census. The ascertained relation of cause and effect between bad well water and these diseases in one section of the State, together with the known existence of the same effect in another section under like conditions of soil, climate and surroundings, reasonably leads to the inquiry whether the same cause has not prevailed there also, though it may not have been so distinctly recognized. Another fact that had been stated and well authenticated before the beginning of the survey, was the good quality of the water when the wells were first dug. It has also been stated that during the construction of the railroads that cross that portion of the State, a number of shallow wells were dug in the surface of the prairie, without reaching much water, and that they often became foul in a few days, though wholly uncurbed.

### *The Wells that were Visited and Examined.*

The following facts were gathered by the writer:

*Morris.*—At Morris, in Stevens county, which is on the Pomme de Terre river, a tributary of the Minnesota, and not within the valley of Red River, the wells are usually bad, and the people generally use the water of the Pomme de Terre. Wells have to be dug rather deep, and through a blue hard-pan. The railroad company are now boring a well having a diameter of sixteen inches. They turn a sort of auger by a single horse-power, and take out the clay as an auger takes out wood, but it has to be lifted out frequently. The material thrown out, now at the depth of 56 feet, is a blue clay with few stones, but some small gravel. No water has been met with yet.

According to Mr. Leonard B. Hodges a well of good water was obtained at Morris later in the season of 1877. It is owned by Judge L. E. Pierce. It is surrounded by foul wells, several of about the same depth, and others of not half that depth. It is in every respect like many other wells at Morris, except in not having wood curbing. It was "driven," *i. e.*, after digging some depth an iron pipe with protected sieving was driven into the clay till water was found which rose in the pipe. This well was good and has remained so.

*St. Gabrielle' Springs. NE¼ Sec. 17, T. 130, 45.*—Three miles from Campbell station, a little south of east. Here are St. Gabrielle Springs, said to furnish "good water;" but although there is a scummy deposit of iron running from them the water tastes alkaline, and is very much like the water of the deep well at the station. There is a boggy area of about two and a half acres, lying a few feet above the water of the stream (Rabbit river) from which the water of the springs runs into the creek. This area is in a bend of the stream, and lies about six feet below the general level of the prairie. The stream is about twelve feet below the prairie, and empties in Bois des Sioux river. It is a small stream and has clear water, but an imperceptible current. In some of the springs which are scattered over the boggy area mentioned, there is a light-colored sand seen boiling up with the water, and in the sand are also some weathered small shells. The bog itself is peaty, and shows some small fresh-water shells. The banks of the stream show nothing but the usual gray drift-clay, containing boulders of granite and many pieces of limestone. The water of the creek tastes swampy and flat. The stones and the gravel of the drift, along the low bluffs of the creek, are mainly of limerock—perhaps three-fourths of them, the rest being granite, &c.

Over the surface of the prairie about, which is nearly flat, are occasional fragments of limestone, which are usually somewhat imbedded in the surface, showing the *glacier origin* of even the latest part of this flat. There is no loam here, nor stratified fine clay. There is only a gravelly or stony clay that is blackened at the surface. On making a few qualitative tests on the spot on the water of this spring, for comparison with that of the water at Campbell Station coming from the deep well there (next mentioned), it was found to agree, even by actual comparison in hand, almost exactly with the water of that well. They both possess abundant sulphates, carbonates strong, and plenty of chlorides. The only perceptible difference in mineral constituents was a little greater quantity

of iron in the well water. On making quantitative examinations Prof. Peckham reports these waters to contain impurities as follows:

| | Total mineral matter. | Organic and Volatile. | Total residue at 30° C. | Removeable Hardness. | Permanent Hardness. | Total Hardness. | Chlorine. | Suphuric Acid. | Lime. | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2. | 62.458 | 12.316 | 74.764 | 10.216 | 15.468 | 25.684 | 10.623 | 4.202 | 6.647 | These waters show a very remarkable similarity of mineral constituents. |
| 3. | 55.454 | 12.481 | 68.295 | 8.756 | 11.960 | 20.722 | No Estimate | 5.370 | 6.864 | |

As the water at the station is foul and unfit for use, while that from these springs is pronounced good, and even has a reputed excellence, both waters coming through the same natural drift deposit, subject to the same natural causes so far as their source is concerned, while the spring water itself is free from noxious odors, it is evident the difference of the waters cannot be indicated by chemical analyses of the mineral constituents. It is also evident that the difference, whatever its nature or origin, must be superinduced by some *artificial*, and not natural, cause; in other words, that there is something inherent in the well, or its artificial surroundings, that superinduces the noxious odors. The trouble, further, cannot lie in the clay of the drift, since the spring water is constantly in contact with the clay, and the well water is brought up through an iron pipe which is said to run to the bottom.

*Campbell Station.*—The well at Campbell Station was sunk several years ago by C. E. Whelpley, of Minneapolis. The following section of this well was furnished by him July 19, 1875:

1. Hard yellow clay with strong bitter water.................. 18 feet.
2. Blue clay.................. 53 feet.
3. Boulders, or rock of some sort.................. 4 feet.
4. Blue clay.................. 39 feet.
5. Blue clay, boulder, gravel and flint.................. 11 feet.
6. Sand, gravel and clay, with some coal.................. 21 feet.
7. Sand, gravel, blue clay, slate, some coal.................. 4 feet.
8. Hard blue clay.................. 15 feet.
9. Clean sand with water, mixed with coal (10 per cent.)..... 8 feet.
   [NOTE—This coal on examination was found to be drift pieces of Cretaceous lignite—N. H. W.]
10. Stony blue clay, but softer below, with more water at the bottom.................. 87 feet.

Total depth.................. 260 feet.

The lower portion of the pipe becoming filled with mud it was found necessary to puncture the pipe at higher levels and admit water above the clay filling. This was done at 176 feet. The water rose within four feet of the surface.

At the depth of 173 feet found wood which was covered with a yellow substance like gold (probable pyrite—N. H. W.) and was heavier than water. Water was obtained at 125 feet, and again at 150 feet, also at 165 feet.

The water pumped out of this well in June, 1877, was turbid with sediment and visible floating particles, and had foul odors. It could not obtain these foul odors from the bottom of the well, nor furnish these floating particles from that depth, since they were evidently both of organic nature. The upper ten or fifteen feet of this well were dug larger than the rest and curbed up with pine boards after the manner of most wells on the prairie.* This was partially filled with water and served as a reservoir. This water must certainly find access within the iron pipe, either through intentional rupturing of the pipe, or loose fitting of the pipe upon the lower joint of the pump. It otherwise passes along the outside of the pipe, between the pipe and the surrounding clay, to the bottom of the well, and is drawn into the pipe at the bottom. This last supposition is hardly possible, as the closeness of the clay about the pipe is probably as perfect as about any stone or boulder, and must be as impervious. Further the surface water would not thus naturally flow downward, being warmer and lighter, as well as being under less hydrostatic pressure, as long as there remained a supply for the pump within the pipe.

About a mile northwest of Herman the railroad passes down a terrace to a lower flat, the change of level being about fifteen feet. Hence the well at Campbell Station, wholly dug in the glacier drift, without any overlying stratified clays, cannot be affected by any lacustrine clay that seems to have been deposited over large areas in other parts of the Red River valley. The glacier drift itself, over wide tracts in this valley, lies at the very surface.

*At Breckinridge.*—At this place, which is near the junnction of the Otter Tail and Bois des Sioux rivers, the grade of the railroad is just twenty feet lower than at Campbell Station, and a hundred and six feet lower than at Herman Station. The distance from Breckenridge to Campbell Sta-

*On inquiry of Mr. Whelpley concerning this well he affirms that no wooden curbing was used in the shallow preliminary digging, the only design being to get room to enter his pipes, and that the dug part was almost entirely refilled, leaving but a shallow basin round the pipe at the surface.

tion is fifteen miles, and from Breckenridge to Herman is thirty-nine miles; the country in all directions being a smooth prairie for many miles, with no visible changes except at the terrace mentioned, near Herman. Yet at Breckenridge, along the river banks, are broken areas of true lacustrine clay. This runs back from the river and covers a small indefinite area. It seems to have been deposited on a slightly uneven upper suface of glacier clay, or unmodified drift, so that it here only occupies the depressions in the glacier clay.

The town has five wells, but only one is used. It is the hotel well, owned by Mr. Sanders, who described it as follows. It is curbed with boards.

*Sanders' Well at Breckenridge.*

1. Mucky, black soil, no stones.......................... 2½ feet.
2. Fine clay, without stones; the same as seen in the river banks.... .. .................................. 16 feet.
3. Gravel—small pieces of limestone, and granite boulders, with some layers of clean sand.....................10–12 feet.
4. Under the last, which furnished water, was an unknown thickness of a black or blue-black clay, that had a different odor. This contained stones and boulders, one of which stopped the further sinking of the well, which, however, did not penetrate it to any considerable depth.

The water of this well, analyzed by Prof. Peckham, shows the following composition, as reported by the Secretary of the State Board of Health:

| | Grains per Gallon. |
|---|---|
| Total solid matter in solution | 86.024 |
| Total organic matter in solution | 12.286 |
| Total mineral matter in solution | 73.756 |
| Total hardness | 19.843 $CaCO_3$ |
| Permanent hardness | 8.756 |
| Removable hardness | 11.387 |
| Sulphuric acid in solution | 1.868 |
| Chlorine | 17.395 |

These results show a general resemblance to those of the well at Campbell Station, and the water of St. Gabrielle Springs, containing nearly the same per cent. of the various mineral peculiarities.

The town well was mainly a bored well, but is curbed with pine boards. The water here varies. Sometimes it has been pretty good, especially at the first, but at the time of this examination it was strongly charged with sulphuretted hydrogen. It is in the

street, and near no sewers. The ground was raised about the mouth of the well to prevent in-drainage from the surface.

*Town Well at Breckenridge.*

1. Soil and clay. .......................................... 4 feet.
2. "Black clay," &c., with gravel stones, no water........... 30 feet.
3. Gravel and sand, with water in abundance, that rose 16 feet in a few minutes..........................Thickness unknown.

On analysis this was found to be a very hard mineral water, containing large percentages of sulphates of lime and magnesia, but "on evaporation had the appearance and odor of urine residue." This water may be taken as a type of the waters derivable from deep wells that penetrate the glacer drift-clay, when not materially changed by contact with organic acids.

The well ot Peter Hanson was dug entirely, 3½ feet square, and curbed with pine boards. The material thrown out is unmodified drift-clay, of a dark-blue color, containing stones and boulders, some ten and fourteen inches in diameter, which show smoothly polished and also striated surfaces. The clay itself is nearly black when wet, and is charged with little stones. This well did not pass through the drift clay, and now affords only "seep water," which, after a month or two, will about half fill the well. It then has a foul odor which is attributed to the "black stuff," as the drift-clay is designated.

*Peter Hanson's Well at Breckenridge.*

1. Clay, as in the river banks; fine and horizontally stratified..4–5 feet.
2. Drift clay, dark colored, hard and strong, no water, penetrated............................................. 50 feet.

The well of Chas. B. Falley, Esq., is altogether in the lacustrine clay. It afforded pretty good water at first, but in a few days it became offensive.

*C. B. Falley's Well at Breckenridge.*

1. Black loam soil.........................................4 or 5 feet.
2. Light colored clay, with some sand, without stones, crumbling in the air..................................... 24 feet.
3. Sand with water (17 feet of water)............Thickness unknown.

From Breckenridge the river was followed in a small row-boat to McCauleyville, opposite Fort Abercrombie, for the purpose of carefully examining the banks.

*Section 21, Town 133, Range 47, Wilkin County.*——Mr. Edward Connelly has here a well twenty-five feet deep, in which the water rises and falls as the river changes, indicating an intimate connection. The well is near the brink of the bank, which rises about twenty-two feet above the river. The bank is made up of about eleven feet of gravelly and stony drift clay, without any overlying lacustrine clay, underlain by a heavy bed of gravel and sand exposed along the bank a short distance above his house. Mr. Connelly also described his well as penetrating these materials only. In this gravel are pieces of Cretaceous lignite and slate. The presence of this gravel bed, and the rising and falling of the water of the well coincident with that of the river, proves a close relation between the two, but not a flow necessarily from the river to the well. There is not much doubt that the gravel bed is itself a vast water-reservoir, which is being filled by inflow from higher levels, and is slowly drained toward the river by hydrostatic pressure. The analysis of this water rather goes to show this to be the direction of flow, since there is much more mineral matter in the well than in the river water, a change that could not be produced by simply filtering through gravel for a few feet.

Descending the river below Connelly's, the light-colored, lacustrine clay, mentioned at Breckenridge, is seen to become more and more developed. and at last continuous, with a thickness of 25 or 30 feet, equal to the hight of the entire banks above the river, with only occasional exposures of the hard-pan clay near the river level. The hardpan finally disappears about two and one-half miles above McCauleyville, near "Aker's place," the last exposure being near the rope ferry. Below this place the lacustrine clay constitutes the entire bluff of the river. Before reaching this place the large boulders, which appeared frequently in the river for some miles below Breckenridge, had entirely disappeared. At the same time timber along the river becomes more and more abundant, and also larger. At first it consisted almost entirely of willows and box-elders, but as this change comes on large trees of white and burr-oak, ash, elm, bass and hackberry make their appearance. The bottom lands widen out, and at the same time become higher, reaching 15 feet above the water, while the lacustrine clay bank, outside of the bottom land, rises about 15 feet still higher. This lacustrine clay covers the country generally, east and west, especially up the tributary valleys; and it is plain to be seen that it will

constitute a different agricultural land from the alkaline plain further south, based on the drift-clay.

There are here then these three formations, all pertaining to the drift:

1. Latest of all, *the alluvium* of the present river, which is mainly sandy, and supports the timber. It is without stratification generally, and swallows burrow in it. Its thickness varies with the hight of the freshet stage of the river, becoming greater toward the north.

2. The *lacustrine clay*, which covers the higher flats, and constitutes the soil of the valley over much of this region. It is of a light and loamy color, horizontally stratified, and is without stones or gravel. This is the sediment of the lake which was drained by the Minnesota river southward during the prevalence of the last ice-period, or on its partial withdrawal.

3. *The blue hardpan clay*—The immediate product of the great glacier, containing gravel stones and striated boulders. This fills the whole valley, running under the lacustrine clay and rising so as to constitute the surface of the country a few miles east or west of the river, becoming rolling, and even hilly, in the Leaf Hills and Coteau de Prairie, but lying smooth and level in the valley. This may have been originally deposited nearly level and smooth, as it now lies, owing to the presence and agency of much standing water, or it may have been somewhat smoothed off at a later date by the lake that covered it. This whole region, then, and especially the general aspect of the flats at Breckenridge, are a fac simile of the Maumee river and the "Black Swamp" region of northwestern Ohio, minus the timber and plus the alkali of the drift clay. Its origin was the same, and probably also its date, both pertaining to the period of the last glacial epoch. The theory advanced some years ago for the manner of deposit of this glacial drift*, here is confirmed by being equally applicable. It was received in these valleys, in a lake of water direct from the ice, and was let down gently without much modification, and stratification as fast as the ice sheet contracted; the horizontally laminated clay, in both places being the result of such lateral distribution of the clayey portions as the lake could effect, and of such later lacustrine deposit as water is apt to form, during its continuance as a lake. Further to

*Proceedings of the American Association for the Advancement of Science, 1872—*The Surface Geology of Northwestern Ohio.* Also the Popular Science Monthly for June and July, 1873—*The Drift Deposits of the Northwest.*

the north it covered the surface of the glacier, but by degrees became embraced further still north, in its general mass, and extended even to the bottom of the ice. It became superficial near the margin of the glacier by the thawing and wastage of the upper surface of the ice.

*McCauleyville*—James Nolan's well, 32 feet deep, affords a strongly alkaline water. It is situated on an irregularly ascending slope from the river toward the general level, and six feet below the general level. It was bored 17 inches in diameter.

*Nolan's Well at McCauleyville.*

| | |
|---|---|
| 1. Soil and black loam | 2½ feet. |
| 2. Brownish-yellow clay, with no noticeable stratification, nor gravel, nor stones | 26 feet. |
| 3. "Black sand," quicksand | 4 feet. |
| 4. Gravel, shells, and rounded stones, like the bottom of a lake, with water, went into it | 1 foot. |

This well seems to have got water in a layer of sand and gravel lying between the lacustrine clay and the hardpan clay, but on analysis it is proved to be heavily charged witn alkaline ingredients.

*Langevin's Well at McCauleyville.*

| | |
|---|---|
| 1. Loam and soil, and light clay | 15 feet. |
| 2. Blue, gravelly clay, with boulders, containing one layer of sand and gravel of 3 feet thickness, at the depth of 40 feet. No water of any amount was found in this well, and it was refilled. This blue clay had pieces of coal and Cretaceous slate, and granite boulders. The sand layer gave offensive water. At about 100 feet there was a layer of about 6 feet of very fine blue clay which makes a good polishing material | 122 feet. |

It is possible, if not probable, that in the foregoing the lacustrine clay assumed a blue color after passing 15 feet, and thus really extends to the layer of sand and gravel mentioned at the depth of about 40 feet, and which is said to have given offensive water. The absence of gravel and stones in the upper part of the "blue clay" was not, in that case, carefully noticed, and the color being the same would very naturally cause it to be set off with the great mass of stony blue clay lying below it. This hypothesis is all the more likely, as the offensive water from the sandy layer may then

be due to the vegetation and muck that would have accumulated in the bottom of the lake which immediately followed the deposition of the stony blue clay—a lake bottom which is also indicated by Mr. Nolan's well at about the same depth below the general level.

In digging Mr. David McCauley's cellar a large deposit of bivalve fresh-water shells was encountered. Other shells were found in digging the cellar of Mr. Longevin. These cellars are far above the river, and yet not so high as the general level of the country. These shells of course belong to the period of the lacustrine clay, either during or following the last glacial epoch.

There are said to be two terraces east of McCauleyville. One is four miles east, and consists of gravel, and one is thirteen miles east and consists of sand. There is a depression, or longitudinal basin, running north and south, between these terraces, in which water stands some years all summer.

At and below Fort Abercrombie are large and numerous selenite crystals. They were found by Mr. Nolan about three miles below the fort, in the slope of the bank of the river, and by the soldiers near the fort in digging a well. They are said to have occurred, in the well, above a heavy deposit of boulders: hence seem to be in the drift, and not in the Cretaceous.

*Moorhead*—In riding over the prairie from McCauleyville to Moorhead, a distance of about 30 miles, sometimes several miles east of the river, only seventeen granite boulders were seen on the surface. These were from six to twelve inches in diameter, and were entirely solitary, being generally half buried in the soil. There was seen no gravelly clay, nor small stones in clusters, nor any alkaline coating, all indicative of the drift clay, throughout the whole ride, but only a fine clay loam.

The well of C. P. Sloggy, at the Bramble House, is 22 feet deep, and wholly in the lacustrine clay, having struck at that depth a quicksand three or four feet thick, giving water. This well was recently dug (in May) and the water is tolerable, though evidently alkaline, and having a taste of the pine curbing. It is, however, less alkaline than water from the hardpan clay. It is said that there is a layer of sand all over this country, including Moorhead and Fargo, at about 22 feet, in which the same water can be got.

The well dug by Sharp and Douglas, situated in the public park, is across the street south from the last, and has the same depth. It now tastes (June 23, 1877,) as if kerosene had been poured into it. It

was dug about a year ago. The kerosense taste is owing to the decay and discharge of the pitch of the pine curbing, and will probably pass off.

Mr. Sloggy has another well dug to this layer of sand about a year ago, about two blocks further south, situated in the street, in an unfrequented part, which at first had a flow of good water, but finally became bad and had to be abandoned. On examination this was found to have the odor of decaying organic matter, and even of animal matter. It has been in disuse and shut for some months, the tight pine curb rising about 20 inches above the ground and covered with a board nailed over it. Hence the contamination cannot come from dead frogs nor rats, nor yet from sewage nor from surface indraining. Like most of the wells in the town the surface of the ground is elevated about the well. by throwing back round the curb the clay excavated in digging.

At John Erickson's Brewery is a well 105 feet deep, dug about two months ago (April or May, 1877). This well is used at the rate of 15 or 20 barrels per day. It is curbed with pine.

*The Brewery Well at Moorhead.*

| | | |
|---|---|---|
| 1. | Light clay | 20 feet. |
| 2. | Quicksand | 4 feet. |
| 3. | Blue clay with gravel and boulders | 80 feet. |
| 4. | Sand, with copious water | |

The water from the bottom of this well was under such hydrostatic pressure that it lifted up bodily "about two feet" of the entire clay bottom of the well, and rose immediately about 80 feet in the well. The water is strongly alkaline, but bright and clear, and is used for beer-making in preference to that of the river. This well was too recently dug, and is too copiously used, to show any markedly bad effect from the pine curbing.

The well of Lamb Bros. is sixteen feet deep, situated under the floor of a livery barn. It is curbed with pine. The water has an alkaline taste, which is said to be "sweet," and is very copiously used. It has never been noticed to be offensive, but will not do for washing. The clay here was but six feet thick, and the sand is said to have been ten.

Jacob Thomas' well is 14 feet deep, curbed with pine, smells and tastes of decaying organic matter, but not strongly of alkali.

*Fargo*—The well at the Fargo House is 25 feet deep, and the water is now good—as good as any water. It was dug one year ago, and is curbed with pine. Probably the fermentation took place last season. Indeed, a gentlemen who was at the house at Christmas affirms it was not so good then as now; yet the landlady, who probably would not notice a gradual change in the water, says it has always been as now; although she also admits it did "taste of the pine and was cleaned out." Another gentleman says it was not used for a time.

The well of J. C. Winslow is 25 feet deep, lately dug and just furnished with a pump. It is a good water also, as good as any hard water. The well is curbed with pine. For a time it was unfit for use.

At the Sherman House is a shallow well, dug four feet square, curbed with pine, has plenty of water which rises about ten feet, and is absolutely horrid with effete vegetable matter. It was dug last year, but has been in disuse for some time.

The well at the livery barn of A. H. Moore is a shallow well. It is curbed with oaken barrels and furnishes pretty good water, but has a pine pump running below the curbing. The water gives off a little sulphuretted hydrogen, but much less than the well at Mr. Moore's house.

The well at Mr. Moore's house is 96 feet deep, curbed with pine. It is an alkaline water, and has a strong odor of sulphuretted hydrogen.

Mr. McHench's well was dug for a cistern and is about 12 feet in depth. It is bricked up and cemented. The water broke in at the bottom and has always been good.

Mr. Roberts' well, near Fargo, is a shallow well, and smells very bad, but was very good at first. It has a pine curb.

A number of other wells were examined at Moorhead and Fargo, but the facts were only a repetition of the foregoing. They were all shallow wells, curbed with pine, had good water at first, and after a few weeks or months became foul and had to be abandoned.

The lacustrine clay is thinner on the Moorhead side than on the west side of the river, and wholly disappears a few miles east of Moorhead, the alkali of the hardpan clay appearing in low exsiccated spots. This occurrs before reaching the south branch of Buffalo river.

On visiting Moorhead again later in the season (September 1877) some of the wells that were unfit for use in June were found somewhat improved, especially those that had been copiously pumped. The Bramble House well was not improved, but rather had become worse. Mr. Sloggy referred to the well of Mr. Mangus Peterson as a curious illustration of the fickleness of the water in the Moorhead wells. This is situated only across the street from his at his house, dug about the same depth (26 or 27 feet) and is curbed like his with pine, but affords the "best water in the town." This seemed to imply that the fault is not in the curbing. On examination of this well it was found, as stated, to afford as good water as Mr. McHench's in Fargo, and was dug in September, 1876. It had been so foul that it was not used for several months. This summer it was emptied repeatedly and began to improve. The neighbors also began to use it, so that it soon acquired a reputation for its excellence. In this case the copious use of the well is what renders the organic impurities imperceptible. By standing it will probably relapse into as bad a condition as before.

*Glyndon*—At Glyndon the wells are all alkaline, and also generally about sixteen or twenty feet deep. They pass at once into the hard-pan clay. They are all curbed with pine. Only one is now fit for use. It is that of the house lately purchased of Major Tenny by James McLenan for use as a hotel. This does not taste of organic decay, but is strongly alkaline. The well at the present McLenan House is very foul, but the former is freely used by the whole village. The well at the Campbell House is not used. It is very heavily charged with organic decay in its foulest stage, and has been in disuse much of the time for four years. Though cleaned out about a year ago, and used slightly for a few months, it is still unfit for use. It is within a few rods of the above named well which is used by most of the families of the village, and has about the same depth. Water from the well in general use was examined chemically by Prof. Peckham, and compared with a similar examination of that from the Campbell House, without showing any important difference in the impurities contained in solution. They are both hard waters. While from one is escaping constantly a volume of noxious organic odors, including sulphuretted hydrogen gas, the other is wholly inodorous, and is freely used for all domestic purposes. It is plain that there is something in the surroundings of the wells which causes the difference. They are both curbed with pine and were dug some years ago. It is also probable that the

copious use of the one keeps it substantially inocuous, while the disuse of the other intensifies the foul qualities. That in constant use is a large open well. That which is foul may be confined and covered. It is also evident that the bad qualities of these wells cannot be detected by the ordinary chemical examination of their mineral impurities. In other words, the foul odors arise from organic ingredients which are volatile. There is no other supposable cause for these odors adequate to the explanation of so prevalent a disorder, than to attribute them to the decaying pine curbing which is co-extensive with the disorder.

There are several other wells at Glyndon, but they are all bad from the same cause. They are sunk in gravelly clay, and get water in gravel.

The well at the Round House, situated somewhat west of the village, was dug in 1872 by the St. Paul & Pacific Railroad, and is reported as follows by Chas. A. F. Morris, who was Chief Engineer when the well was dug:

*Round House Well at Glyndon.*

| | |
|---|---|
| 1. Black soil | 1 ft. 3 in. |
| 2. Yellow quicksand | 12 ft. |
| 3. Blue quicksand, sheets of turf and vegetable deposits | 3 ft. 6 in. |
| 4. Blue clay and drift wood | 2 ft. |
| 5. Blue clay | 2 ft. 7 in. |
| Total depth | 21 ft. 6 in. |

This section is interesting, as it reveals a layer of drift wood 18 feet below the surface. While this was probably deposited by the current of Buffalo river, which runs near Glyndon, during some earlier history of its channel, which then must have occupied a different position from what it does now, it may still be due to water-logged drift wood that was gathered along the shore of the ancient lake that once extended to or even beyond Glyndon. The character of the material overlying the drift wood ("yellow quicksand") strongly indicates the fluvial rather than the lacustrine origin of the drift wood. Its not having been discovered at other points is cumulative evidence of its not extending generally under the country about Glyndon, as it would be more likely to do if of lacustrine origin. Hence it is not likely that the bad odors of the wells there are attributable to vegetable decay from that source. If it were demonstrated or admitted that vegetable decay is the cause of

these odors, it would be folly to overlook the chief known source of such contamination (the pine curbing) and search for it in the soil or clay, or buried drift wood.

At Fisher's Landing, just below Crookston, on Red Lake river, the grade of the railroad is made of gravel, rounded by water action, similar to that seen in a number of places along the road between Glyndon and Crookston, where wave-action has carried away the clay from the drift, and has left the gravel stones strewn over considerable areas. A double handfull of these pebbles, from one-half to one inch in diameter, picked up without selection, afforded seventeen of fine, compact limestone, and four of metamorphic rock. This shows probably an average proportion of limestone pebbles to metamorphic in the drift of the Red River valley in general; though it is probable the limestone pieces would be more numerous still further north, and less abundant toward the south. These limestone pieces are strewn with the drift all over the western portion of the State, even to the Iowa state line, large pieces sometimes being found in the southern tier of counties. They come from the Winnipeg limestone.

*Winnipeg*—By the courtesy of the officers of the Red River Transportation Company the party were taken to Winnipeg and there made further examinations.

Connell and Burke's well, dug about a month, is 56 feet deep. The water was at first good, but now has a faint taste of sulphuretted hydrogen. This may be attributed to the wood curbing placed in the well, which is of spruce. The well went through 40 feet of fine brick clay, and 16 feet of stony clay, with boulders of granite and limestone.

Wm. Hespeler's well on a lower terrace level, dug three years ago, was used last year by two water-carts in distributing water throughout the city, and was good, but now it is little used, and has a sulphuretted taste. It passed twelve feet through brick-clay and obtained water in quicksand; has pine curbing.

Wm. Hespeler's old well, on the same level, dug four years ago near the last, formerly had a sulphur taste, but now furnishes a beautiful cold water. It is also twelve feet deep. It has a pine curbing.

Thos. Maxwell's well is near the last two; was dug this spring, and furnishes perfectly good water. It is the same as the last two in all essential particulars, except that it is copiously used by three water carts in delivering water in the city. Its depth is also a lit-

tle greater, but the water is from quicksand. The overlying clay was found to be, as in those, about 12 feet. No stony clay was met with in these wells.

The Messrs. Chambers Brothers have just completed a well, and put in wooden curbing. It is on the upper flat and 57 feet deep, much of the depth being in a stony clay. The water is alkaline, and as yet has no taste of sulphuretted hydrogen, or organic odors.

The well at the Union Hotel is "sweetly alkaline." It is just dug, has a wooden curbing, and is 57 feet deep; in gravelly clay.

The well at the Free Press building was dug four years ago, and is 59 feet deep. The water is alkaline and sulphuretted. The well is curbed with pine, which still affects the water. The water rises from a gravelly clay deposit near the bottom, and stands within ten or twelve feet of the surface. It is not much used.

[NOTE—The first well of Mr. Hespeler, mentioned above, is at the Orilla House. It is near a barn, with a manure pile very near. It was foul, and on being cleaned two or three dead gophers were taken from it. His second well is at his brick block, but not more than forty feet from the first. It was also foul and "stagnant" last year, but on being more pumped became good again. The Maxwell well is between them and in a low barnyard or muddy spot. It is used by three water carts. The tight clay of which the surface consists seems to shed all surface impurities whenever the slope is away from the well. This is shown by the Maxwell well which, though favorably situated for surface indrainage, is perfectly free from these bad odors, and is largely used.]

The lime rock at Andrew's Rapids, twelve miles below the city of Winnipeg, is quarried and used for all building, and even as dressed cut-stone for large ornamental fronts. That at Rocky Hill, or Stony Mountain, where the penitentiary is built, 17 miles northwest of the city, seems to be of the same general age and texture, but is more fossiliferous and irregular. Its color is a light buff, or faded drab. It is in all respects, exactly like the boulders and gravel strewn so abundantly over western Minnesota.

At this place the lacustrine clay makes a cream-colored brick. Below it, or in it, is a sand layer, which does not seem to be everywhere met, which gives good water not perceptibly alkaline. The drift-clay below gives a strongly alkaline water. There are some artesian wells in this neighborhood which rise from below the blue drift-clay, or hardpan.

*White Earth.*—Mr. G. A. Morrison, of the White Earth Indian Reservation is authority for the statement that the same difficulty with bad water is encountered there. The wells are dug in the drift

clay, and are all curbed with pine, with one exception. That also was at first, but the curb was taken out and stone walling was put in. The water was bad before the change, but now it is good.

*Detroit.*—Wells at Detroit enter gravel within twenty-five or thirty feet, and find a good lining and chalybeate water in abundance. Wells are curbed with pine. The country here is rolling, and the drift clay is very gravelly; indeed the gravel which furnishes the water of wells seems to rise to the very surface. No trouble with foul water.

*Perham.*—Here the soil is a loam, and the subsoil and drift are gravelly, allowing free underground drainage. Water is found at 20 and 30 feet. Some pine curbs have been used, but there has been no trouble with foul water. The supply is copious.

*Brainerd.*—Many of the wells curbed with pine at this place are foul in the same manner as at Fargo, Breckenridge, &c. Attention was directed to the fact by Dr. J. C. Rosser, of Brainerd, in connection with the occurrence of numerous cases of typhoid fever which had been attributed to the use of bad well-water. The soil here is sandy, with some clay, with a clayey sub-soil. In company with Dr. Rosser and Dr. V. C. Smith, of Duluth, the writer visited and examined about twenty wells. They were found to be all curbed or walled with pine. They have an average depth of thirty-five to forty feet and penetrate a stony clay deposit. They have mostly been dug for a number of years. The majority have a distinct taste of decayed wood, and are turbid with floating particles from the pine. The smell is not so rank as in many in the Red River Valley, and in most of them no offensive odor can be distinguished, though to the taste there is a distinct trace of organic decomposition. They seem to have a great deal of detached floating (or suspended) fungus growth, which is of a yellowish-brown color and inodorous. These wells are in what might be styled the second stage, or one of fungus growth and dead wood, which is a natural sequence of the rank and odorous stage which they first pass through. The occurrence of frequent cases of typhoid fever both at this place and in the Red River Valley, taken in connection with bad well-water in both places, was suggestive of the possible existence of a common cause. It was for this reason that Dr. Rosser desired an examination of the Brainerd wells. Three samples were procured for chemical examination. They were examined by Prof. Peckham with the following results:

*Analysis of Well Waters from Brainerd.*

| Owner's Name. | Serial Number. | Total Solid Residue. | Mineral Residue. | Organic and Volatile Residue. | Permanent Hardness. | Removable Hardness. | Total Hardness. | Chlorine. | Free Ammonia—Pts in 100,000,000. | Albuminoid Ammonia—Pts in 100,000,000. | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C. H. Alsop... | 49 | 32.287 | 24.283 | 7.004 | 8.172 | 6.44 | 14.593 | 42.728 | 132. | 49. | Sulphuric and Carbonic acids, a trace. |
| Al. White..... | 50 | 16.519 | 13.250 | 3.269 | 6.129 | 3.210 | 9.339 | 4.027 | 0. | 0. | " " |
| Leland House. | 51 | 37.241 | 30.937 | 6.304 | 9.923 | 4.378 | 14.301 | 50.900 | 26. | 13. | " " |

No. 49, above, was from a well used by a family in which there had been a recent case of typhoid fever. The water had been condemned some time before, and the well cleaned with the discovery of several dead mice; but since the cleaning the water had not been noticed to be bad again. The fever occurred after the use of the well subsequent to its being cleaned. At the time the sample was taken the well had been standing again unused, from the removal of the family, for a few weeks. It has a pine curbing. On visiting this well it was found to be perceptibly contaminated with organic decay, which was perceivable by the smell as well as by the taste.

No. 50 was from a well that was not known to have any bad taste or to have been accompanied, in its use, by any cases of fever, though curbed with pine.

No. 51, at the Leland House, there had been several cases of typhoid fever during the summer. Indeed, with the single exception of the case in the family of Mr. Alsop, all the cases in the town, (season of 1877) were confined to this house. The water from this well, which is in the kitchen and not well protected from surface in-drainage, has a distinct odor and taste very much the same as those in the Red river valley, though less rank. This well is curbed with pine.

These analyses give abundant evidence of organic matters in these wells. The albuminoid and free ammonia can have no other plausible explanation ; but although at the present time their use is visited with typhoid fever, they are no worse than many others which were examined, and probably no worse than most of the wells of the place that are so curbed, during some former portion of their history. In former years this town has been severely afflicted with typhoid fever. At one house, formerly use as a hotel, it had been so common that the house was for some months a very

hospital of typhoid fever, but now is not so much troubled. This well, however, is still bad from the same cause, but has passed its foulest stage. In other cases when these wells have been unused for some time, the odor becomes intensified; and it is a singular fact that familiarity with and use of the water renders it impossible to distinguish it, and even makes it agreeable. The most of the wells examined were said to have "good water" by the owners. Occasionally a man is found who says his well "tastes of the wood;" and also one occasionally who really knows that the water becomes foul from the pine, and recommends instead that *oak* be used.

In Mr. Follet's well, near Mr. Alsop's, the decay is just begun, the well having been dug this summer. It shows in iridescent films that float on the surface of a cupful, but does not now taste very bad.

*Herman.*—The deep well at this place was drilled by C. E. Whelpley, of Minneapolis, and the following record of it was furnished by him:

| | |
|---|---|
| 1. Blue clay | 124 feet. |
| 2. Rock | 65 feet. |
| Whole depth | 189 feet. |

Water from the top of the rock rose to within six feet of the surface. There was considerable coal on the surface of the rock. The rock was very hard to drill and showed several changes within the sixty-five feet. The following letter may here be given pertaining to this well.

MINNEAPOLIS, MINN., 23d March, 1878.

*C. E. Whelply, 1506 3½ Street South:*

DEAR SIR:—I have just received your letter of March 22d, written at Herman, containing samples of rock taken from near the bottom of the well you are drilling there; in which you ask me what kinds of rock they are, and the probability of getting a flowing well by drilling deeper. The samples are as follows, as you numbered them, in descending order.

No. 1. "Found 124 feet under blue clay, seven or eight feet thick." This is the same stone as the limestone boulders that lie strewn over the surface of the Red River flats from Winnipeg to Big Stone Lake and beyond, and is found outcropping at the surface beyond the limits of Minnesota in Manitoba. It is a fine grained, buff, magnesian limestone, of the Silurian or Devonian age. Your let-

ter seems to convey the idea that this lies in a layer seven or eight feet thick immediately over the rock of the next number. That would be anomalous and unexpected. It is very probable that this fragment is from a drift boulder, and that the thickness of seven or eight feet was occupied with a compacted boulder-mass, mostly made up of such rock. It is true that nearly all the boulders and gravel of the drift in that whole region are of this rock, and, according to a well known fact, boulders are much more frequent in the lowest ten feet of the drift than in any other part. * * * * * * * *

No. 2. This is a quartzose, granite, parti-colored by flesh-red feldspar. It is but a small piece, but is compact and fresh. It has but little mica.

No. 3. This is a white, micaceous quartzyte, in which there seems to be a little gray labradorite.

No. 4. This is a fragment of crystalline feldspar, with one rectangular cleavage, and a dull, vitreous luster,—an orthoclase.

No. 5. This fragment consists of glassy quartz and mica.

No. 6. Mica schist, with associated talcose rock.

No. 7. Mica schist with veinings of calcite.

No. 8. Mica schist, changed in color by heat applied since it was taken out of the well. (Same as No. 6.)

No. 9. Coarse mica schist. This came from a depth of 186 feet, and is said to have begun at 180 feet.

A glance at these samples is sufficient to show that your well is now in the metamorphic rock, the strata of which are discordant and highly tilted, and from which there are no instances of artesian overflows that I have ever heard of. All our artesian wells are in higher geological horizons. I should unhesitatingly discourage you from drilling any deeper in hope of getting a flowing well. These rocks are several thousand feet in thickness, and are followed by granites and syenites, in which there is no better chance of artesian water.

Very respectfully,

N. H. WINCHELL.

### *The Surface Geology of the Country.*

It is not possible to give a full account of the surface deposits of the valley of the Red River of the North. This sketch will be confined to such general views as may be gathered from a hasty reconnoisance, based on such facts as an inspection of the banks of the river at numerous points and the examination of the foregoing wells have afforded. The full details will have to be filled in by subsequent and more elaborate exploration.

It is found that the lowest portion of the drift consists of a stony clay, which below contains more abundant gravel, and throughout many stones and boulders. It is also probable that many wells which have been supposed to have passed through it, have only struck water-bearing courses of gravel or sand in the clay itself. This deposit is generally blue. When it is at the surface it is

lighter colored. The stones which it contains are from various formations, but about 75 per cent. of them seem to belong to the Winnepeg limestones. The rest of the stones are granitic. This clay also contains Cretaceous debris, such as slate and lignite. Such lignite sometimes is rather plentiful, and indicates that the Cretaceous formation, which is rather fragile and incapable of enduring long transportation, underlies large portions of the valley, if not the whole of it, and that the clayey portions of the stony clay have been very largely derived from the disintegration of this formation. This is further evinced by the occurrence of crystals of selenite in the drift deposits near Fort Abercrombie, the sulphate of lime being one of the alkaline salts that seems to have been abundantly in solution in the waters of the Cretaceous ocean. This vast clayey deposit of unmodified drift rises to the surface round the margins of the valley and spreads out in extensive flats, on both sides of the river, and between Breckenridge and Big Stone Lake toward the south. This flat surface passes by insensible degrees to one more rolling, and at the same time becomes more stony, toward the east, making the bulk of the Leaf Hills in Minnesota, and toward the west making the Coteau de Prairie in Dakota. It is essentially and typically a glacier-deposit, its varied aspects being due to the agency of water, present at the time of deposition, and either running with considerable current so as to wash out the clay and make stratified gravels and sands within the mass, as in the Leaf Hills and in the Coteau, or in the form of standing water, by which the clayey parts were retained and the whole spread out with a smooth upper surface, without much modification of structure.

After this drift clay was deposited there was for a long time a large lake of fresh water standing over the valley of the Red River of the North, which had an outlet toward the south by way of the Minnesota valley. This lake probably began its existence during the last period of ice, and was caused, at least during the latter part of its prevalence, by the glacier ice itself, which obstructed the northward flow which the natural slope of the country indicated and required. This lake began its existence on a much more restricted scale near Big Stone Lake, and it received and spread out evenly, as already noted, the glacier drift as fast as the glacier brought it forward. It grew toward the north as fast as the retreating ice sheet made way for it. At length, when there were partial or periodical openings in the northward outlet by way of Winnipeg, its shore line advanced or receded as the outlet opened or closed by the seasons of the waning glacial winter. Hence the

fine deposits which it spread widely during the times of its highest stages were withdrawn by the receding beach line during the times of its shrinkage and partial discharge northward. Hence the lacustrine clay is not spread so widely as would be expected from the existence of beach marks at some elevated levels.

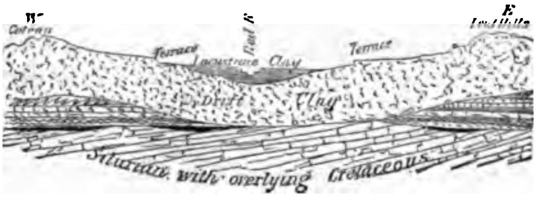
It was the water of this lake during its period of agitation and instability that produced the next noteworthy member of the drift deposits in the Red River valley. This is a layer of gravel and sand, sometimes containing fresh water shells in abundance, as at McCauleyville, which nearly everywhere underlies the lacustrine clay and affords water. This sometimes is several feet thick. It lies directly on the upper surface of the boulder clay, but it does not extend generally over that surface where the lacustrine clay is wanting.

The lacustrine clay is horizontally stratified, and contains no stones (at least none have been seen) nor gravel. It is fine and close. It is of a yellowish or earthy color; or at considerable depth it may be bluish. It makes cream-colored brick. It contains less of the "alkali" than the drift clay. Its area is about twenty-five miles wide in Minnesota, but it extends westward into Dakota with about equal width, or perhaps greater, and runs northward into Manitoba with an increasing width and thickness. It is barely found south of Breckenridge. Its special location is along the river, covering a belt on either side, and widening east and west up the tributary valleys. But the most of the surface of the Red River valley, within Minnesota, seems to be formed of the drift clay, showing stones and gravel in abundance. There is not much doubt that this lacustrine clay was once spread more widely over the surface of the drift clay, and was removed by the action of the slowly retreating shore line.

The latest of the surface deposits is the alluvium of the river, which sometimes becomes a very important one. Its amount and area are greater further north. While this is generally an incoherent, amorphous and arenaceous deposit rich in vegetable humus, and is confined to the immediate valley between the bluffs formed of the older foregoing clays, yet there are some places where it is more compact, and has an undulating stratification that somewhat resembles that of the lacustrine clay into which it then seems to pass. Such cases are not common, however. It is this deposit that bears the timber that occupies the valley. It is much more abundant where the lacustrine clay forms the river banks than where they are composed of drift clay.

The adjoining diagram, representing a transverse section of the valley at Moorhead, illustrates the superposition of these parts of the drift.

FIG. 1.




Section across the Red River Valley at Moorhead.

### *The Chemical Peculiarities of the Waters of the Valley.*

In general the waters of the entire valley are alkaline*, whether taken from wells, springs or running streams. That is to say, they contain considerable amounts of lime, magnesia and soda, combined as sulphates, carbonates and chlorides. They are not often very bitter, indicating a moderate amount only of the chlorides of calcium and magnesium, but they contain on the other hand not a sufficient quantity of sodium chloride to allow of denominating them saline. The soda is probably in the form of bicarbonate, with a small proportion of chloride, the lime as carbonate and sulphate, and the magnesia as sulphate. Indeed the most predominant taste is that of sulphate of magnesia, or epsom salt. The waters of the valley are not equally affected by these mineral ingredients. Those

*The analysis of the "alkali" of the western prairies, taken from the south bend of Moose river, in Dakota territory, by Prof. E. H. Twining, is given in the report of the Superintendent of Public Instruction of the State for 1870. [Ex. Docs. of 1871.]

| | |
|---|---|
| 1. Coarse gravel, principally quartz | 28 per cent. |
| 2. Finer material, principally quartz sand | 18 per cent. |
| 3. Fine dust, (passes through a sieve of 80 to an inch | 54 per cent. |
| Total | 100 per cent. |

COMPOSITION OF NO. 3.

| | |
|---|---|
| Loss by ignition (water and organic matter) | 3.99 per cent. |
| Insoluble in acids (principally quartz sand) | 67.47 per cent. |
| Soluble silica | 1.36 per cent. |
| Sulphuric acid | 7.43 per cent. |
| Carbonic acid | 5.98 per cent. |
| Lime } Combined with Carbonic Acid | 3.62 per cent. |
| Magnesia. } Combined with Carbonic Acid | 1.18 per cent. |
| Potash | 1.05 per cent. |
| Soda | 6.18 per cent. |
| Alumina and Sesquioxide of irom | 1.72 per cent. |
| Chlorine | Trace. |
| Total | 99.98 per cent, |

springs or wells that obtain their water from the drift clay are the most uniformly and strongly affected. Those whose source is in the lacustrine clay, or from the sandy layer between it and the drift clay, are much less alkaline, as a general rule, though it is not at all impossible that that layer should contain water derived immediately from the underlying drift clay, which would be as strongly alkaline as any directly from the drift clay. The waters freest from these mineral impurities are those found in the streams. Of these streams those will be found least alkaline that flow wholly or mostly over the lacustrine clay, and hence they are in the northern portion of the valley, where the lacustrine clay spreads wider. The water of the Bois des Sioux is purer (so far as these ingredients are concerned) than that of the Otter Tail. The former is the outlet of Lake Travers, and it is confined wholly to the immediate river valley, having only inconsiderable streams flowing from the drift clay surface. The Otter Tail, on the other hand, rises in the Leaf Hills, and flows for several miles, and nearly its whole course, over the alkaline drift clay.

These alkaline qualities are remarkably affected by organic impurities. In some of the natural waters of the valley this effect is noticeable, particularly in those which are sluggish. Some low grounds, in which vegetation grows rankly some portions of the season, but in which these alkaline waters collect and stand for some weeks or months during the early part of the following season, are offensive with sulphuretted hydrogen, while the waters themselves are foul and sickening. Such effects are due to the reaction of the decaying vegetable growths on the alkaline salts of the water, which converts the sulphates into sulphurets, which in turn are changed by the carbonic acid present, with the separation of free sulphuretted hydrogen, and the formation of carbonates. The small streams of the valley are also apt to be nearly stagnant during the summer season while they choke up with grass and other vegetation, and become heavily charged with organic matters. These react on the sulphates and materially affect the mineral condition of the waters, and their usefulness for domestic or agricultural purposes. They generally continue to be used for watering places for stock, and are sometimes hauled in barrels for household purposes. If these reactions are perfectly balanced by even portions of organic matters and alkaline minerals the soluble sulphates in the water may be wholly converted into insoluble carbonates, thus mainly freeing the water both of organic acids and of the usual mineral ingredients. But this is usually not the case. In the spring months, and during wet seasons, the alkaline ingredients

overbalance the organic acids; but during the summer and fall, when the springs run low, and the developement of organic substances, and their decay, are most active, the organic impurities are in excess of the alkaline, and the waters show their worst condition —which is prolonged by the flatness of the surface, and the consequent slowness of natural drainage.

The waters of the valley generally do not have an offensive odor. It is only in stagnant and confined water these effects are noticeable. The chemical interaction is so slow that the resulting gas escapes unobserved, and the waters are slowly purified by the change. Suspended organic matter is also rapidly oxydized by contact with the atmosphere.

The following report of Prof. Peckham to Dr. C. N. Hewitt, shows more fully the chemical peculiarities of the waters of the valley from different localities :

*Dr. C. N. Hewitt:*

MY DEAR SIR—I have the pleasure of submitting the following report of the examination that I have just concluded of the specimens of water collected on our trip through the Red River Valley. They were gathered from the following named localities:

No. 1. The flowing well at Tintah, St. P. & P. R. R.
No. 2. St. Gabrielle Springs, near Campbell, St. P. & P. R. R.
No. 3. Well at Campbell Station, St. P. &. P. R. R.
No. 4. Otter Tail River, at Breckenridge, St. P. & P. R. R.
No. 5. Bois des Sioux, at Breckenridge, St. P. & P. R. R.
No. 6. Well at Connelley's, on river, four miles northwest of Breckenridge.
No. 7. Wild Rice River, west of Fort Abercrombie.
No. 8. Well at Nolan's Hotel, McCauleyville.
No. 9. Well at Brewery, Moorhead (Artesian).
No. 10. Well at Bramble House, Moorhead (surface).
No. 11. Well at Glyndon, good—in general use.
No. 12. Well at Glyndon, bad, McLenan's.
No. 13. Town Well at Breckenridge.

They were selected for the following reasons:

No. 1 was from a well that was dug only a few feet into the level prairie, which furnishes a stream of water constantly flowing over its brink. The water of this well is considered of fair quality, and is used at several of the stations on the St. P. & P. R. R. in that vicinity. It was therefore thought best to examine it.

No. 2 is from St. Gabrielle Springs about 2½ miles from Campbell Station on the St. P. & P. R. R., situated on the banks of a small stream called Rabbit River. These springs are the only natural outlet for water in that part of the country so far as could be learned.

No. 3 from the well at Campbell Station was represented as being very bad, and quite unlike either Nos. 1 or 2. As this well was quite deep and in the immediate neighborhood of 1 and 2 it was thought desirable to know in what respects they differed.

No. 4 is considered by the inhabitants to be the best water in the upper Red River Valley, and with No. 5 is extensively used along the banks of the two rivers. As these two waters in mingling form the Red River, it was thought desirable to ascertain their quality and their differences, if such existed.

No. 6 was selected because there was reason to believe that it was the river water filtered through beds of gravel which formed the river bottom at that point. It was thought desirable to know if such filtration removed mineral matter from the water.

No. 7, from a tributary of the Red River has a bad reputation. It was thought advisable to compare this water with that of the Otter Tail.

No. 8 appeared to be bad from excess of mineral matter, and at the same time it was different from the well at Breckenridge. For that reason it was thought best to examine it.

No. 9 was selected as representing the water of a very deep well, and No. 10 as representing the water of a shallow well from the same locality, that had been recently dug. It was thought best to compare them.

Nos. 11 and 12 were from two wells very near together and very unlike, one being considered very good and the other very poor. It was thought best to compare these and ascertain if possible why the water in the bad well should have become sulphurous.

No. 13 was the town well at Breckenridge. When selected it was supposed to represent the bad well water of that locality. It was probably much worse than the average.

The accompanying table gives the results of the examination of these specimens. In estimating the total mineral and organic constituents, 100 c. c. were evaporated over a water bath and when dry the residue was heated to 130 deg. C. in an air bath. It was then cooled and weighed, and the amount calculated as "total solid residue." This residue was then heated over a Bunsen's lamp and the organic matter burned off. The residue remaining was calculated as the mineral matter in solution and the difference as volatile and organic matter. This difference can not be safely computed as organic matter excepting in those cases when the mineral ingredients existed chiefly in the form of bi-carbonates. Sulphates in some instances and chlorides in nearly all, retain water at 130 deg. C. and when the amount of such salts is comparatively large, they prevent the complete combustion of the organic matter by fusing and enclosing particles of carbon. No. 13 may be noticed as an example of this difficulty. The organic and volatile matter estimated from difference is 91.412 of which only 22.298 grains is actually organic matter.

The soap test was then employed to determine the total hardness, permanent hardness, and by difference, the removable hardness. Also the sulphuric acid, lime and magnesium. This test gave satisfactory results on all of the specimens but one. In No. 11 the permanent hardness was greater than the total hardness; that is, the water was harder after boiling than it was before. The tests were repeated until no doubt could be entertained of the fact. I cannot explain this anomalous result. For $SO_3$ the soap test appears to give very satisfactory results, but for lime and magnesia the process as described are highly empirical and give results of but little or no value except when applied to water containing

those bases as carbonates, and which at the same time is free from alkaline sulphates and chlorides. Waters containing the last named salts are rendered harder by them. If then the total hardness is used as a basis for the estimation of the lime, it is obvious on a moment's reflection, that if, as advised by Parke, the total hardness in tenths of a cubic centimeter be divided by four and a drop of ammonium oxalate solution added for every four degrees of hardness in a carbonated water, the same rule applied to a water containing alkaline chlorides or sulphates would cause an addition of an excess of the precipitant which adds to the hardness. For this reason I found it impossible to estimate the lime by the soap solution in Nos. 7, 9, 11 and 12. I have but little confidence in the results given for the other numbers. The magnesia was still worse for the entire hardness produced by alkaline chlorides or sulphates is included in the magnesia by Parke's method, as neither chlorine or sulphuric acid in combination with the alkalies is precipitated either by boiling or by ammonium oxalate. I have therefore omitted the estimates of magnesia in all cases as in those in which the determination was made. I had no reason to believe the figures reliable. The chlorine was estimated by a standard solution of silver nitrate, verified in No. 13 by precipitation and weighing; in which case the results corresponded to one one-hundredth of a grain.

We have reliable data therefore for comparing the waters in reference to the amount of mineral matter in solution, the total and permanent hardness, the sulphuric acid and the chlorine.

A comparison of the different specimens shows a range of amounts of mineral matter in solution varying from 6.304 grains to 390.158 grains in a gallon.

Numbers 13 and 8 are properly termed mineral waters. Numbers 1, 2, 3, 10, 11 and 12 are very hard well and spring waters; numbers 6, 7, and 9 are ordinary hard waters, while numbers 4 and 5 are quite pure river waters when we consider that they flow from and over sedimentary formations.

Numbers 4 and 5 are quite free from sulphates and chlorides. It will be further observed in reference to the remainder that with the exception of number 13 the sulphates are not extremely large, while again excepting number 13 the chlorides are very large, especially in numbers 7, 8, 10, 11 and 12. These results are unexpected, and I am especially surprised to obtain unmistakable evidence that the water of the Bois des Sioux river is purer than that of the Otter Tail—in fact is the purest water in the valley. A remarkable difference is also observed between the water of these rivers and that of the well at Conelley's. The mineral matter has increased about four fold, the chlorine seven fold, and the sulphuric acid three fold. These facts imply that the well water cannot be simply the river water, filtered through the gravel of the river bank.

So far as these results bear upon the subject of our inquiry they show that the waters of the Red River Valley do not contain large amounts of sulphuric acid, but that they are heavily charged with chlorides, probably largely combined with lime and magnesia. As a consequence they produce very hygroscopic residues when evaporated, and the accurate determination ot the total solid residue or mineral constituents becomes extremely difficult if not impossible. An examination of the table shows that in every specimen in which the chlorine is large the organic and volatile matter is also large. This is not on account of an excess of organic matter but because the latter item is estimated by loss, and the loss consists of water retained at 130 deg. C., and also of a part of the chlorine from the decomposed magnesium chloride.

I cannot venture an opinion based upon these results, as to the cause of the water of many wells becoming fœtid on standing, or when the well is used but little or not at all. Number 11, is a colorless, odorless water, used by the entire population of Glyndon. Number 12. is from a well but a few rods distant from No. 11. It is of a yellowish color, contains a black sediment, and is heavily charged with sulphuretted hydrogen gas. Examination has thus far proved them to be of the same general character, with no difference in any respect that can be regarded as important. If the solution of this question is deemed desirable, I should recommend the selection of a number of typical specimens and their complete analysis, for organic, as well as mineral constituents. I should also advise a microscopic examination by an expert if possible. I would recommend as preliminary to the selection of these specimens, a further exploration of the valley, and an examination by the soap test, and for chlorine, of a large number of waters, particularly those from springs, and if possible from wells that are free from exposure to filtration of surface drainage, and filth filtered from sink drains, barn yards, and the streets of towns.

As an illustration of the difficulties attending the drawing of any conclusions from the results thus far obtained, Number 9 may be mentioned. The permanent hardness is less than in any other specimen, indicating an absence of magnesium, sulphate and chloride. There was no calcium and magnesium chloride in the residue. Therefore, no water was retained at 130 deg. C. The 9.147 grains of organic and volatile matter is doubtless organic matter, and is a comparatively large quantity. The source of this organic matter it is impossible to determine, unless its character be ascertained. The water smelled as if contaminated with sewage from a sink, and may contain the soakage from the Brewery in which it is situated, or the organic matter may be derived from the clay. The bad well at Glyndon is near a barn, and the surface around it was covered with kitchen slops when the specimen was obtained. The residue from the water had a decided odor of urine. The question whether these organic contaminations are derived from the subsoil or from surface infiltration, becomes therefore a fundamental consideration, with reference to the prevention or cure of the undoubted bad qualities of most of the water examined. The amount of calcium bi-carbonate is not large in these specimens of water, while chlorides are abundant. It would not therefore be advisable to recommend the use of Clark's lime process.

An examination showed the clay to contain a large amount of organic matter. No other result could have been expected. Respectfully submitted,

S. F. PECKHAM,
State Chemist.

| Number. | Total Mineral Matter. | Organic and Volatile. | Total Residue at 130° C. | Removable Hardness. | Permanent Hardness. | Total Hardness. | Chlorine. | Sulphuric Acid ($SO_3$). | Lime ($CaO$.) | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 53.119 | 5.078 | 58.197 | 2.081 | 8.026 | 10.507 | 13.075 | 2.568 | 2.098 | Colorless, odorless, had deposited iron. |
| 2 | 62.458 | 12.316 | 74.764 | 10.216 | 15.468 | 25.684 | 10.623 | 4.202 | 7.647 | " " " " |
| 3 | 55.454 | 12.841 | 68.295 | 8.756 | 11.960 | 20.722 | No estimate. | 5.370 | 6.864 | Turbid, odor of putrid brine ; iron. |
| 4 | 8.279 | 4.142 | 12.421 | .584 | 5.545 | 6.129 | 1.400 | 1.467 | 2.000 | Colorless, odorless, had deposited iron. |
| 5 | 6.304 | 5.137 | 11.441 | 3.210 | 4.086 | 7.296 | 1.400 | .700 | 2.654 | Yellowish, odorless. |
| 6 | 26.617 | 3.210 | 29.827 | 3.210 | 7.880 | 11.090 | 10.098 | 3.502 | 2.980 | Colorless, odorless. |
| 7 | 33.156 | 11.440 | 44.596 | 0.000 | 8.436 | 8.436 | 28.077 | 0.000 | No estimate. | Odor and taste swampy, yellowish. |
| 8 | 196.656 | 34.556 | 231.212 | 43.779 | 20.430 | 64.209 | 42.728 | (?) | 6.864 | Musty, dirty yellow, much iron. |
| 9 | 31.988 | 9.147 | 41.135 | 12.550 | 1.167 | 13.717 | 9.740 | 2.334 | No estimate. | Colorless, odor like a sink drain, deposit like clay, |
| 10 | 48.967 | 43.662 | 93.629 | 9.340 | 6.712 | 16.052 | 156.204 | 2.334 | 2.918 | Colorless, odor marshy, deposit like clay. |
| 11 | 41.736 | 17.628 | 59.364 | (?) | 20.038 | 13.133 | 46.280 | 1.467 | No estimate. | Colorless, odorless, deposit of iron. |
| 12 | 49.675 | 20.488 | 70.163 | 3.502 | 5.837 | 9.339 | 56.096 | 2.200 | No estimate. | Yellow, odor of $H_2S$, deposit black. |
| 13 | 390.158 | 90.412 | 481.570 | No estimate. | No estimate. | No estimate. | 1.061 | 174.211 | 45.658 | Residue on evaporation had the appearance and odor of a urine residue. |

| | Total Mineral Matter. | Water, etc. retained at 130° C. | Organic Matter. | Total Residue at 130° C. | Residue in $BaSO_4$. | Insoluble, $HCl$ $SiO_2$. | $Fe_2O_3$ and $Al_2O_3$. | $SO_3$. | Cl. | $Fe_2O_3$, $Al_2O_3$ and $Fe_2P_2O_8$. | $CaO$. | $MgO$. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 390.158 | 69.114 | 22.298 | 481.570 | 51.542 | 4.412 | 3.035 | 174.211 | 1.061 | 10.723 | 45.658 | 29.443 |

## *Conclusions.*

The foregoing ascertained facts will warrant the statement of sundry conclusions which may be given briefly as follows: They pertain to the solution of the question—whence come the foul odors of the wells in the Red River region?

1. The drift clay affords a strongly alkaline water.
2. The lacustrine clay affords a slightly or non-alkaline water.
3. There is generally a water-bearing stratum of sand, or of gravel and sand, between the lacustrine and drift clays, which affords a good water in nearly all cases.
4. The drift clay comes largely from the disruption of the marine Cretaceous clays, and that accounts for its greater alkaline qualities—while,
5. The lacustrine clay is a deposit of superficial fresh waters.
6. There is a water-bearing stratum in or near the bottom of the drift clay which is under considerable hydrostatic pressure, and water from it rises nearly or quite to the natural surface.
7. Nearly all of the wells in the Red River Valley are curbed with wood of some sort, generally pine.
8. This wood undergoes rapid changes due to the chemical reactions between organic acids and alkaline waters, as above described under natural circumstances.
9. This source of foul odors is abundantly sufficient to account for all the phenomena.
10. The organic matters cannot come from the lacustrine clay, because the odors are equally prevalent all over the western part of the state where no lacustrine clay is found.
11. These organic matters cannot come from the drift clay, because they are found in wells that do not enter the drift clay.
12. Any organic matter in either of these clays would have long since passed through the stage of decomposition necessary for the production of such gases, and entered into a carbonaceous and fixed condition.
13. The assumed cause of these odors, whatever it be, must be one that is coextensive with the effects—hence,
14. They cannot come from surface indrainage, since they occur in wells where that is impossible.
15. They cannot come from sewerage or other artificial underground sources, because they occur generally in wells where such contamination is impossible.
16. This fermentation of the sap and pitch of the pine sometimes has the effect of giving the less alkaline waters of the valley, in its incipient stage, a taste as of kerosene, and the appearance of small globules and films of oily consistency and spacific gravity floating on the surface.
17. The effect of this change may be obviated, or mitigated, by copious use of the wells; and it may be wholly avoided by using earthen or iron pipes, and discarding the wooden curbing.
18. Shallow, open wells, dug in the surface of the prairie and having alkaline water, may become offensive in the summer, though without curbing, by the decay of fine organic particles blown into them, or washed into them, from the rank vegetation of the prairie turf.

In the progress of this investigation the writer became impressed with the sufficiency of pine wood to produce such odors, by a simple test experiment; viz:

Two quart glass jars were filled with good well-water, not alkaline, taken from the same well. Into one was put a quantity of pine chips, but into the other nothing was placed. They were exposed to the atmosphere of the same room, the glass stoppers being inverted and loosely placed over the wide mouths. While the jar with nothing but clean water remained clear and inodorous during the continuance of the trial, and indefinitely thereafter, the other went through the changes indicated by the following.

*Records.*

Dec. 4. Place a quantity of seasoned pine sticks in a wide-mouthed glass jar in common well water. The jar stands on a table in a warmed room, loosely covered by the inverted glass stopper. The sticks all float.

Dec. 5. A portion of the sticks have sunk to the bottom of the jar, and small bubbles of some gas adhere to some of them.

Dec. 6. Nearly one half of the sticks have settled to the bottom. The jar when uncovered smells strongly of fresh pine. Gas bubbles are more numerous.

Dec. 7. There is no noteworthy change.

Dec. 8. There is no noteworthy change, except perhaps a stronger pine odor.

Dec. 9. The pine smell is very strong, and less fresh.

Dec. 14. A thin scum floats on the surface. There is an odor of sourness.

Dec. 19. The floating scum begins to settle, some of it swimming in the water.

Dec. 21. The scum on the surface adheres to the glass, and looks gummy. The odor is less sour, and somewhat offensive.

Dec. 25. The odor is offensive, and there is a gelatinous gum adherent on the glass, and along the water level.

Dec. 28. The odor is strongly offensive.

Dec. 31. The odor is very offensive and foul, as from organic decay. There is a white, gelatinous or gummy scum, as of fungoid growth, adherent on the glass about the water level, and floating in flocks on the surface. It sometimes appears, especially on disturbance of the jar, in globular masses of ⅛ to ¼ inch in diameter.

Jan. 1. The microscope reveals great numbers of organic germs, which are oval in shape and appear to be of the *Ciliata*.

Jan. 10. A jelly-like fungus, about a quarter of an inch thick, floats about in the water and on the surface. The odor is very offensive.

May 1. There is a swimming fungus which tends to settle to the bottom of the jar. The water is slightly turbid, and yellowish-red. It has a musty smell, and also is plainly acidulated. The microscopic animals are equally abundant, and of various forms.

In the presence of such a source of organic decay and contamination found in nearly every well in the whole region, it is evidently unnecessary, and even absurd, to search for any other.

These considerations bring up the whole question of the prevalence of typhoid fever as an endemic disease in western Minnesota and Iowa, but it is not germane to this report to enter on its discussion. Nothing more can be done here than to call the attention of those interested in the sanitary condition of the state to these facts, and to suggest that possibly the climate has less to do with such diseases than has been imagined, and that probably their causes lie nearer, and within the grasp of ordinary preventive measures. The effect of the water is not always an immediate typhoid fever, but an aggravated diarrhœa, and then dysentery, which lead finally to typhoid fever. This is the testimony of Dr. J. C. Rosser, of Brainerd, and also the experience and observation of many others. Sometimes the fever assumes a local name. At Bismark it is known as the "Montana fever." In Moorhead it is known as the "Red river fever," but they seem to be all essentially typhoid fever.

# III.

## RECONNOISANCES.

### *1. Into Wright County.*

Information having been received from Hon. William Pfiender of the existence of some evidences of coal in Wright county, an examination was made of the designated localities. On Sec. 33 T. 119 N., R. 25 W., land of John Marth and Fred Wanderzee, along the north branch of Crow river, pieces of Cretaceous lignite have been found in considerable quantities; also, along a creek, Sec. 25 T. 119 N., R. 26 W., on land of Joseph Plant. These are all float pieces, exactly similar to what have been found in numerous other places, though perhaps more abundant. An examination was made in company with Mr. John Marth, of Delano. The banks of the streams are composed entirely of drift, and largely of blue hardpan. The lignite was seen in the bed of the creek, having been most observed at or near fording places, where it was most likely to be brought to the surface and seen by passing travelers. At no point could any Cretaceous beds be seen *in situ*. Along the stream are numerous pieces of slate, or fissile shale, likewise derived from the Cretaceous, though here immediately from the hardpan drift. It is possible that Cretaceous beds would be struck below the drift, in sinking a shaft.

### *2. In Rice County.*

In company with Prof. L. B. Sperry, a number of localities of rock-outcrop were visited in Rice county, for the purpose of determining the main characters and the continuity of the Trenton and Shakopee. The details of the geology of this county are given in the report of Prof. Sperry, and it would be simply repetition to give them here. The most interesting observation made, was the discovery of a carbonaceous layer in the Lower Trenton, exposed along Prairie creek, which without previous drying will ignite from a common match, and burn with a flame.

*3. In Goodhue County.*

The examinations made in Goodhue county were in company with Hon. H. B. Wilson and Dr. W. W. Sweny, and consisted of a visit to the quarries at Wanamingo, Zumbrota and Red Wing, and the collection of two boxes of specimens.

The eastern part of the county is rolling, with frequent rock exposure in the brows of the hills, but the chief covering of the rocks is the loose loam with a thickness of 50 to 75 feet, sufficient to make the ascents generally tillable, while in the western portion the drift prevails so as not only to fill up the old rock-canons, but to convert the surface into an undulating prairie. The drift gradually thins out eastward under the loam. It seems to have suffered extensive denudation by aqueous forces, so that what is left of it visible under the loam is coarse and gravely or stony. A very large boulder of red or flesh-colored granite projects above the surface of the loam on N. W. ¼ of section 29, in Belle Creek. It lies on high land, and is conspicuous from a distance. It rises about nine feet above the ground, and has a circumference of 26 paces. It belongs, of course, to the old drift epoch, and not to the last, as it is embraced in and partly covered by the loam, the loam not having covered generally the newer drift in that part of the state. It is evident that the denudation to which the old drift-surface was subjected, produced the material for fine clays which gathered in quiet spots, since under the loam, in old canon-valleys, and also in some places less protected, there are extensive laminated clays. The Red Wing pottery-clay comes from below the loam, on Sec. 3, Goodhue, Goodhue county, and has a light gray, bluish color. The whole excavation was unfortunately covered by water, and nothing could be learned of the relation it bears to the drift or the loam. The Terra Cotta clay of Red Wing, is the blue interior of the terrace that accompanies Hay Creek. It is in horizontal laminations, and upwardly passes gradually into the loam. Between the two drift periods it seems that the country had a forest covering, since in Goodhue county, no less than in Fillmore and Olmsted, there are abundant remains of timber and of the old soils. On Sec. 2, Wanamingo, on the high prairie, land of Wm. Boulett, a log of what appeared to be hemlock or coarse pine, was found in digging a well, at the depth of 26 feet below the surface. This was embraced in a "bluish-blackish" clay, apparently a soil, and was five or six inches in diameter. It was covered with a hard, gravely, yellowish clay and by the loam that covers that part of the county. Also on Sec. 5, Belvidere, land of John Holtz, in the valley of the creek, was found wood twenty feet

under the surface, in the gravely blue clay, or under it. On Sec. 24, Chester, Wabasha county, a log a foot in diameter was found in digging a well, upon the high prairie, said to be about twenty feet below the surface. This log was well preserved and could be chopped. It lay on the ground near the well for some years.

At Wanamingo the Lower Trenton is quarried in a low bench along the Zumbro. This bench rises higher and higher above the Zumbro in descending the stream, and finally the St. Peter sand rock appears, and then the Shakopee limestone, which, at Zumbrota, supports the south end of the bridge over the river, rising about 25 feet above low water. The stone for the abutments and foundation for the Forest Mills was taken out of this rock near the mills; but the stone for the bridge at Zumbrota came from the Trenton in higher land near Zumbrota. The Forest Mills are about two miles below Zumbrota. The Shakopee here causes a terrace-flat on which is situated Zumbrota village, but there is a covering of drift-gravel and loam.

A few aneroids were taken at Red Wing, and a general section was obtained of Barn Bluff. The top of the bluff is covered with loam, which also hides the rocks from sight down a sloping descent of about 70 feet. If this be regarded as containing limestone the thickness of the limestone will amount to 120 feet. From the top of this there may have been destroyed several feet of limerock. The general section then consists as follows, in descending order:

| | |
|---|---|
| 1. Slope and limerock.......... ...................... | 120 feet. |
| 2. Sand and green-sand, and limerock..... ................ | 40 feet. |
| 3. Massive sand, the upper portion being white, the lower portion yellow. From this the glass sand is taken......... | 50 feet. |
| 4. Sand and green-sand, with cement of lime and magnesia, with distinctly aluminous portions. To the flood plain......................................... | 80 feet. |

Barn and Soren bluffs dip toward the east a few degrees. There are extensive quarries in these bluffs, that furnish a fine building material. The stone now being used in the bridge over the east channel of the Mississippi at Minneapolis is from the quarries of Mr. Carlson in these bluffs.

### *4. On the Northern Pacific Railroad.*

The details of this reconnoisance, so far as they relate to the water supply for domestic uses, are given in the chapter devoted to *Water-supply of the Red river Valley.* The only rock exposure along the line of the Northern Pacific R. R. after leaving the neigh-

borhood of the Junction with the St. Paul and Duluth R. R., within the State, occurs in the vicinity of Motley. This is a range of granite, about four miles north of the station, on sections 21, 22, 27 and 28, extending north and south. It widens out toward the north before disappearing under the drift. Its extent is about a ¼ mile across from north to south. The country round about for miles is nearly level, and covered with Pinus Banksiana, *Lam.* It escaped the observation of the land surveyors of the N. P. Company, and the land was entered and described as having "no stone." There are here hills and ridges that rise fifty or seventy feet above the surrounding country, and in some of them the rock is bare. It cannot be said with certainty that this rock exists in all these hills and ridges, but it probably does. There are but few spots where any drift boulders can be seen, the country—even these hills—being covered with sand or sandy loam. The surface of the rock is old. It does not show recent glaciation, the appearance it presents being rather that that would be attributed to aqueous forces. The surface is, in general contour, *moutonne-ed*, but not so markedly as the knobs and hills of Marquette and Duluth. Since this glaciation it is evident that water has covered this rock for a long period—water probably which spread the fine sand over so wide a belt, extending almost uninterruptedly from near Thompson to this place.

The rock rises in undulating sheeps-backs, and in the intervals is covered with sand and turf. It consists, taken all together, of at least three different qualities, viz: First, a gray syenite (?) which has a greenish mineral like serpentine and also both white and flesh colored pieces of feldspar, rather fine grained. Second, a dark, diorytic, trappean rock that occurs in apparent, wide dykes in the granite. This varies from a petrosilex, (or what may be taken provisionally for that rock) to a real dioryte. Third, a serpentinous granite, i. e. a granite (with white feldspar) that contains a green mineral undistinguishable from the green mineral of No. 1, with evident lumps of mica. These three kinds may not be the only variations that the rock will on quarrying exhibit, but they are the only noteworthy ones observed. They are all rather fine-grained. The green mineral of No. 1, is sometimes more abundant in streaks or veins, even two inches wide, than throughout the rock, giving the rock a striped aspect, often two or three thin veins coming within a foot. This rock was discovered and purchased of the N. P. R. R. by Mr. C. H. Alsop, who is beginning to open it for sale. Being in the midst of a country destitute of known rock, especially of granite, this locality has much importance. It will furnish a building material of the most durable kind, and possessing all the excellencies of the granite of St. Cloud or Sauk Rapids.

From Brainerd to Motley the country is about the same as at Brainerd, i. e., a sandy plain. The timber consists largely of Bank's pine. Wadena and Perham are on prairie openings. At the latter place the subsoil is a gravel-and-sand to the depth of at least 15 or 20 feet, as revealed by wells that get good water at that depth. This gravel-and-sand is like that on which Minneapolis stands, but is not overlain by so distinct a loess loam. The loam here is only soil-deep, and also contains occasional little pebbles, the same as found in the gravel below, showing that the loam is only a soil formed from the sand and gravel of the subsoil. This subsoil of gravel-and-sand continues westwardly, through and beyond the prairie on which Perham stands, and into a sparsely timbered and undulating country, even beyond Frazzee City. It is noticeably *free from boulders*, and consists only of gravel and sand. On approaching the Leaf Hills the gravel and sand becomes gradually coarser, with occasional stones, the general surface also becoming more broken. Further on the gray hard-pan, very stony, comes in, at first gradually as if the gravel and sand were horizontally merged into it by the accession of clay and larger stones, but finally so as to comprise the mass of drift, as seen in the cuts by the grade of the road. The hills are composed of this hardpan. At Detroit the surface is undulating and somewhat rolling, but mostly a prairie, being fairly on the west side of the Leaf Hills. There is a little timber west of Detroit, but the prairie sets in within a couple of miles, and continues to Moorhead. The subsoil at Detroit is the same as at Perham, a gravel and sand, the surface-soil being a loam, derived locally from the subsoil by disintegration and the action of vegetation. The roads are always dry; the wells go into gravel for water at the depth of 25 or 30 feet, the supply being good—limy or chalybeate—and copious.

Above Brainerd about five miles, are the French Rapids, in the Mississippi river. Their immediate cause is a quantity of drift boulders, which lie mostly along the left shore, though they are also of course throughout the bed of the channel; but their original cause is probably the nearer approach of the bed-rock toward the surface of the drift. A short distance above these rapids, on the left bank is a high drift bluff composed largely of clay, but containing numerous stones and boulders. Below the rapids the river runs along the left side of an alluvial, timbered island. The fall in the rapids is about three feet. No bed-rock can be seen. There are a few boulders also along the right bank just above the head of the rapids. The bottoms are covered with deciduous trees, but the upland mainly with Banks' pine, with some white and Norway pine.

East of Brainerd the country is mainly one of plains, which are superficially sandy, but they must be closely underlain by a clay deposit, since they often become wet, when large swamps are caused by the contained water. There are also numerous ridges of hardpan-clay soil and subsoil, in which a different outward appearance is very marked. The trees become larger, and consist of a greater proportion of deciduous species, while the Banks' pine entirely or almost wholly disappears, and the Norway and white pines prevail. Toward the Junction the hardpan clay comes in in full force and continues to Duluth, except when overlain by the red laminated lacustrine clay of Lake Superior.

At the Northern Pacific Junction, prominent and bare ridges of slate, four to six in number, rise about 25 to 40 feet. They run nearly E. & W., or by compass north 80 degrees east, varying to north 75 degrees east. The slaty cleavage runs nearly parallel with the direction of the ridges, or north 85 degrees east. In approaching from the west, along the N. P. R. R. this slate becomes perceptible a short distance before reaching Komoko; and, by the topography and changed drift, rock is evinced for several miles even before reaching that place. These ridges run through Komoko and the N. P. Junction, and at least to Thompson, where they have been wrought, the slate quarries being about two miles from the railroad in Sec. 29, T. 49 N., R. 16 W. They are not continuous, nor uniform in height nor in length. They rise, and sink again below the surface, with an irregular alternation. Sometimes a section across the range would show only three or four series and sometimes there might be six. Often the intervals in one series are opposite the ridges in the adjoining one. The rock itself varies from an argillyte suitable for roofing, to a very dark, or gray quartzyte that shows less slaty cleavage, yet must probably be taken as a part of the same slate group. The rock of this latter kind seems to be found in some of the ridges exclusively, while the argillyte prevails in others. Outwardly they have about the same appearance, as they lie in long parallel, undulating ridges, and perhaps they should not be so prominently distinguished as this description implies. These ridges are moutone-ed, but there are no scratches or other marks showing the direction of any glacial action. They have three systems of jointage planes crossing each other at various angles, so that the rock itself is cut into large angular blocks to great depths, which not only facilitates the quarrying of the slate, but the natural disintegration of the ridges by frost. The adjoined sketch shows a ground plat of one of the ridges, with the different systems of joints:

FIG. 2.

Ground plat of a slate ridge at Junction.

*Explanation of Figure 2.*

1\. 1. Slaty cleavage, nearly perpendicular, runs north, 85° east.

2\. 2. Joints that cut the slaty cleavage at right angles, but slope west at an angle of about ten degrees from a perpendicular. They are sometimes so numerous as to number four or five in the interval of a foot.

3\. 3. Joints (or bedding) which run parallel with the ridges, but slope south at an angle of about 45° with the horizon. The southern slopes of the ridges are formed by the splitting off of the layers, while the northern slopes are apparently caused by the breaking off, by an irregular and shifting fracture of the same layers, and have an angle about the same as the southern slopes, but in the opposite direction.

4\. 4. Less distinct oblique joints that do not seem to be as numerous as the foregoing, but which, on the quarrying of the rock, are seen to penetrate to as great depth. These aid in causing the superficial parting of the rock into rhomboidal and angular masses. They slope N. W. at an angle of about 25° from a perpendicular.

The horizontal extent east and west is about six rods.

Figure 3 is a perpendicular section running north and south across these ridges, showing the direction of the slaty cleavage and of joints 3. 3. of Fig. 2.

This slate appears to be the same as seen at Little Falls, on the Mississippi below Brainerd, but it here shows none of the concretionary hornblend, or dioryte rock, and, taken all together, is somewhat finer grained, not showing an evidently micaceous composition.

FIG. 3.

Section across the slate ranges at Junction.

# IV.

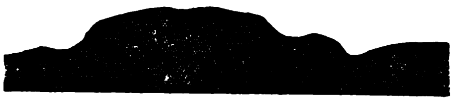
## THE GEOLOGY OF MORRISON COUNTY.

This reconnoissance was made in company with Mr. N. Herrick, of Minneapolis. The first observations were made at Pike Rapids, which are at the mouth of Swan river, but are in the Mississippi. They are so named from Lieut. Z. M. Pike who built a stockade and wintered with his men here in 1805–6. They are caused by a mica schist rock which rises in some spots about six feet above the water at low stage, but lies mainly in the river channel. The only outcrop on the shore seen being in the left bank. The schist is filled with small crystals of garnet and coarse crystals of staurolite. Besides these clumps of schist rock rising in the channel of the river, there is an abundance of boulders of all kinds, both in the river and on the shore, the banks rising about 30 feet and consisting of coarse material. The rock itself seems to dip, at least it has a laminated structure which dips, toward the northwest at an angle of about 45 deg.

At Little Falls the rock that occurs in the river is a roofing slate similar to that at Thomson, but varies from a mica schist to an argillyte, with some veins of white opaque quartz. The rock in some places also varies to a massive, compact hard rock with sharp jointage angles, whch, when broken, has nearly the color and texture of the staurolite crystals, if fractured, found in the rock at Pike Rapids, but seems to be more nearly a dark quartzyte. Besides these variations there are nearly continuous layers of more or less lenticular and concretionary lumps or nodules, sometimes six or eight inches thick, of a rock very firm and dark-colored, but which on weathering becomes superficially lighter-colored and shows needles and spangles of dark-green amphibole. The matrix in which these crystals lie is not well characterized, but is quartzytic and perhaps also feldspathic, but is dark-colored, so that on a fresh

fracture the amphibole crystals are hardly observable. They appear on the weathering of the rock. By far the greater part of the whole is a micaceous argillyte, with slaty cleavage nearly perpendicular, or sloping a very little toward the N. W. (N. 18 deg. W.), the strike being N. 18 deg. E. There is also a system of joints that gives the rock, viewed across the river, the appearance of being conspicuously stratified, with a dip up the river of about 45 deg. from the horizon. The slatiness, which is nearly perpendicular, is somewhat injured, at least superficially, by the frequency of joints, of which there are at least two systems intersecting each other at a small angle, thus cutting the slates into rhomboidal masses, as they weather to pieces. The following diagram (Figure 4) is designed to show the relation between the slates and the three systems of joints mentioned. The general exposure is an irregular expanse in the river channel, and bottom land, but does not rise in ridges or knobs, though the occurrence of a dyke of dark trap, and the massive quartzytic rock, seem to have been the primary cause of this protrusion upward of the underlying formation which is generally more deeply buried under the drift. This is known to extend under Little Falls village, being encountered in wells and cellars.

FIG. 4.



Jointage of the slate at Little Falls.

A little distance further down the river, yet scarcely outside the limits of the village, rock is exposed on "the point," and consists, in general, of a hard, dark-colored dioryte, containing mainly amphibole in coarse crystals, and a little feldspar (labradorite?). The outward characters of this rock are the same as the concretionary lumps that exist in the slate already described. It is here simply in larger area and bulk. It is parted by joints that cause it to fall to pieces in slabs and cuboidal masses. This *may be* here in the form of a dyke, but its relation to the slate cannot be seen. The point which is formed by it is considerably higher than the bottom land on either side, but falls away somewhat on receding from the river, the rock itself becoming lost to view in the swampy bottoms, or involved with the drift of the river-bluffs. On long-weathered surfaces, under the action of the water, there is a ridged and furrowed form that shows the same direction and trend as the slatiness of the slate, i. e. N. 18 deg. E. These ridges are about $\frac{1}{4}$ inch apart, and about $\frac{1}{8}$ or

¼ inch high, separated by intervening furrows. This surface configuration is apparently due to the alternate arrangement of the mineral contents, and perhaps has its origin in a metamorphosed condition of the slate itself, or of the sedimentary rocks from which they both may have been derived. Thus this could not be of the nature of an igneous dyke, but a metamorphic variation due to the complex nature of the original sediments. This view is strengthened by the occurrence of a similar diorytic rock, in concretionary masses, in the slate itself, running in more or less regular layers or lines. This alternation of mineral contents does not pervade the whole of rock exposed on "the point," but it is a conspicuous feature in some places. The ridges are composed of the lighter colored minerals, and the furrows of the amphibole. The adjoining figure (Fig. 5.) illustrates the alternation of these ridges and furrows.

*Fig. 5*


Arrangement of Mineral Contents at Little Falls.

*Explanation of Figure 5.*

1. Bands of dioryte.
2. Alternating bands of amphibole and feldspar.
3. Furrow mainly occupied by a band of amphibole.
4. Feldspar band.

Opposite the village of Little Falls a trap dyke of basic doleryte, apparently about 10 feet wide, appears in the slate, going diagonally across the slate; and on the south side of the dyke, in the lee of its protection against the current of the river, as well as against, possibly,

the ice of the ice-period, the slate (or schist) is decomposed to the depth of four or five feet at least, making a greenish-blue clay, or incipient kaolin.

The slate at Little Rapids is visible, along one or both sides of the river, as far up as the ferry, perhaps three-quarters of a mile above the village.

On the N. E. ¼ Sec. 13, (R. R. land), Little Falls town, on the west side of the river, is an area of dark granite, rising in smooth knolls a few feet above the surrounding country, which is flat and rather wet, though sandy, and in fact is an eastward continuation of the flat of the west bank of the river at Little Falls. This rock is not in all places a true granite, but varies to a dark, apparently trappean rock, which is an amygdaloidal melaphyre*, containing, however, a light-green mineral like serpentine. There are also variations to a non-amygdaloidal melaphyre with scattering mica-scales.

At the mouth of the Little Elk river, two and a half miles above Little Falls, the slate seen at Little Falls again appears, but here the direction of the slatiness is N. 30 deg. or 35 deg. instead 18 deg. east. The creek runs across it and cuts into it. The dam is made between the rock bluffs on either side. The slate is known to extend up the Little Elk only about half a mile.

N. E. ¼ section 26, Belle Prairie. Here is an outcrop of granite. It rises not more than eight or ten feet above the general surface, which is nearly level. It is rounded over but is not striated. Its color is sometimes pink and sometimes gray. It is rather massive than schistose. Its area probably extends over on the next section north. Similar rock occurs again about two and a half miles northeast of this place on section 18, in the next town east.

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## PRIMITIVE MAN AT LITTLE FALLS.

### *(1). The Stone Cutters.*

During the examination of Pike Rapids some search was made for Pike's winter stockade. Near the principal exposure of the bed-rock, along the east bank, abreast of a small island scantly turfed over, there is a blind excavation in the river-bank which consists of loose

* This term is used here in the indefinite sense preferred by Bernhard Von Cotta.

sand and fine gravel, that has the appearance of having been artificial, but no old timbers could be found in the vicinity. Paris Roy, a half-breed living at Little Falls, says he remembers hearing his uncle, a trader for the American Fur Company, named Charles La Rose, stationed seven or eight miles above Little Falls, at that time, relate the fact of Pike's stopping here and describe the place as on the east bank, and below the rapids. This excavation is really below the main rapids, though there is half a mile of rapid water below it, caused by boulders, without exposure of the bed-rock.

About this excavation, which may or may not have been the site of Pike's stockade, are pieces of chipped white quartz, which from their sharpness, and their color, indicate an artificial origin, and attract the eye of the visitor. It was only after a handful had been gathered, that at last an imperfect arrow-head was found. These chips, at this point, were found only over a small area, indeed they were not looked for at other points up or down the river, nor at any depth below the surface. This quartz, which is white and opaque, was evidently taken from some vein in the slate in this neighborhood, for the slate at Little Falls has several veins of that kind of quartz.

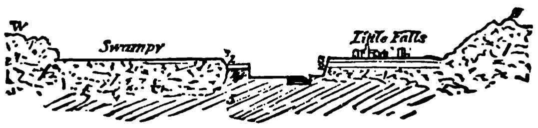
Subsequently however, these chips were found to extend over a larger area, and to be incorporated with the materials of the river banks. Further examination at Little Falls disclosed this interesting discovery. They are found, not only on the surface of the flat on which Little Falls village stands, especially near the river, but on excavating the bank near the river, making a perpendicular section, they are found to extend downward three or four feet into the sand and gravel. A person in digging half an hour might find twenty-five or thirty. The material in which they occur is a homogeneous sand, passing downward gradually into a coarse sand and finally into a gravel. This flat along the river on the margin of which they are found, is about twenty-seven feet above the river, and is now never covered by it. The bank itself may be divided into three parts, as follows, in descending order:

1. Loam sand, gravelly below.
2. Gravel, becoming stony below.
3. Hardpan-drift, containing boulders.

The plain on which Little Falls stands, is about a mile wide, and extends along the river, as an abandoned ancient flood-plain, southward, and becomes that on which East Minneapolis is situated. Toward the south its average width remains about the same as at Little Falls—perhaps becomes less—but toward the north it increases in width, and at the same time rises above the river, and finally

comes apparently to constitute the entire country about. Brainerd (with the sandy country east of it) is on such a plain; towards the west a sandy plain of the same nature, and the same level extends much further, though, opposite Little Falls, it is occupied to a large extent with wet land and often by tamarack swamps. On either side of the river, outside of this plain, is a line of drift bluffs which have a rolling coutour and rise from 50 to to 75 feet higher, constituting a greatly different character of country, and occupying the general level for an indefinite distance east and west from the river. Northward from Little Falls, while the included plain becomes wider, and covered with a coarser sand, these bluffs gradually become lower. It seems as if the plain slowly rises to the level of these drift-bluffs, and the bluffs themselves then are lost to view, or are so broken, and involved with other drift knolls and ridges, that they seem to have no relation to the river itself. In traveling by the new railroad, lately constructed between Brainerd and St. Cloud, this change is observable. The road itself, at least between Little Falls and Brainerd, runs throughout on this plain. In reverse order the depth of the river below this plain increases in going northward. At East Minneapolis it is from 25 to 30 feet above low water; at Shingle creek it is about 37 feet; at Champlin it is 43 feet; at Dayton 45 feet; at St. Cloud 58 feet; at Brainerd about 60 feet. No measurements have been taken above Brainerd. Along the river at a lower level is another flat, or bottom-land, which is the present flood-plain. The hardpan drift which prevails in the bluffs on the east side of the river, and which underlies the sandy plain above described, seems to be of the old drift epoch (see report on Hennepin county for 1876), and lies on the slate at the Falls. The adjoining diagram (Fig. 6) represents a section across the Mississippi valley at Little Falls:

FIG. 6.




Section across the Mississippi valley at Little Falls.

*Explanation of Figure 6.*

1. Hardpan drift, on the east side covered with a fine clayey loam.
2. Gravel and sand.
3. Sand, loamy above and gravelly below; 60 feet above the river at low water.
4. Trap dyke.
5. Slate rock.

The quartz chips occur in No. 3, and abundantly on the flat (somewhat lower than the average here) directly opposite Little Falls, in the neighborhood of the trap dyke. They extend up and down the river also an unknown distance. They were found at the mouth of the Little Elk, two and a half miles above Little Falls. The belt on the west side which seems to afford them is about 40 or 50 rods wide, but something less than ¼ mile on the east side. On the west side they appear in the soil when large trees tear it up.

These chips are all angular, some of them being as sharp as knives, and perfectly unwaterworn, and they occur in a waterworn deposit. They vary in thickness from that of paper, and the size of one's fingernail, to one and two inches across, of irregular, angular forms. Almost no other coarse material is found in the surface sand in which they are found; and whatever there is, is waterworn and rounded. The chips are generally without evidence of designed form, and nearly all the angular pieces are also destitute of all evidences of artificial shaping, so far as their forms are concerned. Only a few pieces were found that seemed to show the work of careful chipping, and they are not perfect. The most certainly chipped form found was taken at Little Elk river, but was of brown chert. Some of these chips are represented on Plate I.

The interest that centers in these chips, and which alone would warrant this extended account of them, involves the question of the age of man and his work in the Mississippi valley. When they were first observed they were taken to be of much later date than they seem to be, indeed they were associated with the builders of the mounds and ridges that are seen at Little Falls and many other places in Minnesota, attributable to a race known as the Mound-Builders, who preceded the present Indian races. But these mounds and ridges at Little Falls are built of the very sand, and are situated on the very same plain in which these chips occur. In other words, the Mound-Builders dwelt at Little Falls since the spreading of the material of the plain: hence they are post-glacial. The chipping race, if these chips are of human origin, preceded the spreading of the material of the plain, and must have been pre-glacial; since the plain was spread out by that flood-stage of the Mississippi river that existed during the prevalence of the ice period, or resulted from the dissolution of the glacial winter. The fortunate juxtaposition of these two classes of human remains enables us to establish this important general truth. The wonderful abundance of these chips indicates either an astonishing amount of work done, as if there had been a grand manufactory in the neighborhood, or an enormous lapse of time for its performance.

There is one other source to which these chips can be referred. The veins of white quartz traversing the slate at Little Falls, from which these chips were originally derived, were observed in one instance (near the mouth of Little Elk river) to split into angular pieces similar to those taken from the surface sand of the plain, under the action of moisture and frost. This was seen at a point where the freshet water of Little Elk river had lately carried away the surface materials, laying bare a large area of the slate. The quartz of the vein, not having a mineral cleavage, yet had an irregular fracturing tendency which resulted in the disentegration of a considerable quantity of the vein. It is supposable that in some earlier history of the river, when it was large enough to cover the whole valley from the drift bluffs a mile east of Little Falls to the drift bluffs several miles west, this same disintegration under natural causes took place, and that by some means the fragments were distributed by the water of the river, perhaps by floating ice, over the flat on which they are found when it was the bottom of the river. This supposition meets with the following obstacles.

1. There is no point throughout the whole region round about where the slate conveying these quartz veins rises to the level of the surface of this plain so as to be within the range of transporting agencies, whether of the water of the river or of floating ice, but the quartz veins are from 40 to 50 feet lower than the flat on which the chips occur.

2. During the high stage of water that formed the chip-bearing terrace, that plain itself was intact from side to side, the present river channel which is cut down to the slate and the quartz veins, not having been excavated.

3. The chips seen at Little Elk river, resembling these supposed human remains, were in the bed of the river, and *under* the drift originally, even the unmodified glacier drift, while the transported chips are *over* the glacier drift and in a water-washed sand.

4. If these chips were the product of natural disintegration, and river distribution they would be expected to show some attrition incident to the long period of wearing they had passed through. On the contrary, while embraced in a water-washed and rounded sand, or fine gravel, they are themselves not worn in the least.

5. The quartz fragments, while mainly destitute of evidence of designed shape, do in a few cases appear to be imperfect forms of arrow-heads or of cutting or scraping instruments, and also have, along the edges, the appearance of having received repeated blows, and present small fresh surfaces of forced fracture.

6. In gathering about three quarts of these chips, eight pieces were found that could be thought to have a designed form, and two of these are of brown chert and undeniably the product of human design.

(Since the foregoing was written, some of these chips have been submitted to Mr. F. W. Putnam, Curator of Peabody Museum of Archaeology and Ethnology, Cambridge, Mass. After an examination he says he has no hesitation in saying that he "considers them identical with those known to be formed by the hand of man when making implements of stone." One of the chert specimens he regards "a finished implement.")

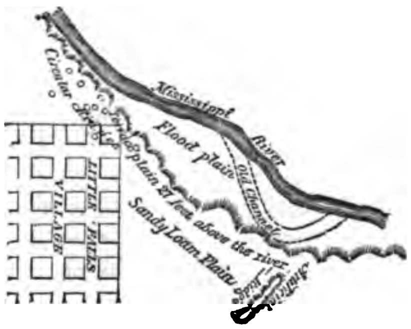
### *(2.) The Mound Builders.*

Mention has already been made of ridges and mounds on the terrace at Little Falls attributable to the early race known as Mound Builders. They have a general resemblance to many others that may be seen in the State, some of which have been alluded to in former reports (Reports on Houston and Hennepin Counties). Their occurence at Little Falls is interesting especially in relation to the possible human origin of the quartz chips that have been described, as they seem to be of later date than the chips. This is proven by the fact that the mounds are built on the terrace plain, and of its materials, in the composition of which plain the quartz chips take part, extending three or four feet below the surface. The mounds themselves are somewhat different from those seen elsewhere, inasmuch as they consist of low, circular ridges, from eight to twelve feet across, rising but two or three feet above the general level. These are scattered over a small distance on the east bank of the river near the northwest corner of the village plat, though perhaps others would be discovered on making a more extensive survey. The following diagram of the surface shows their position relating to the river and the other ridges. They may have been designed for habitation, having been formed at first by slightly excavating the surface of the ground, and then building rude arched coverings supported by wooden branches and enclosed by earth. As these decayed and fell in, the resulting forms would be exactly what are now seen. Beyond the limits of the village, further north, is an interesting ridge, nearly straight, running obliquely back from the river and a hundred and eight paces in length. This is of a very different nature, though plainly artificial. It is from three to four feet high. It has two low spots, or openings through it, which separate it into three main parts. It does not extend to the imme-

diate river bank, but is separated from it by an interval of several rods. The design of this ridge is not evident, but it must have had some relation to other works in the neighborhood. It may not however, have the same age as the small circular ridges above mentioned, since there is some possibility that the latter may have been built by the present Indian races.

About fifty earth-works or mounds are found on the border of a small lake on Sec. 35, Belle Prairie and Sec. 9, Little Falls, six miles east of the village of Little Falls. They follow round the shore of the lake, which is know by the Indians as "The Lake between the Hills."

FIG. 7.




Mounds and ridges at Little Falls,

(3.) *In other parts of Minnesota.*

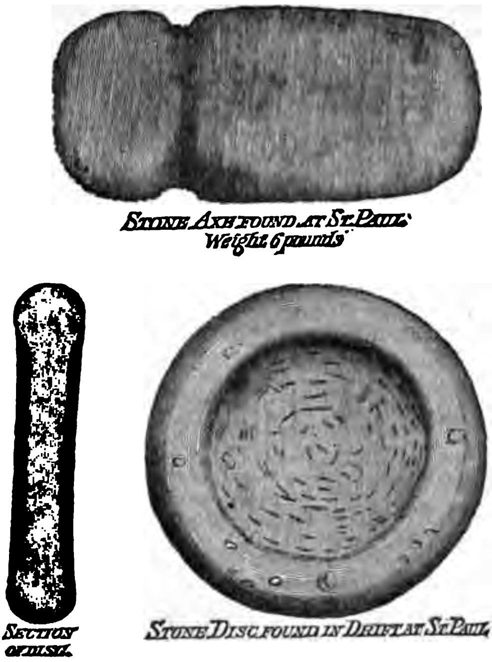
A great many flints and stone implements have been found in the State indicating the former prevalence of a race, or races, analagous to the stone-workers of Europe. Whether these stone implements are referable to the older stone-working race, which would make them pre-gracial, (palæolithic), or to the more recent nolithic stone-workers, or to both of them, has not yet been ascertained; but the disposition has been general to assign them to the latter. It may be possible, however, that the palæolithic race is represented, and the quartz chips at Little Falls would seem to indicate that to be the case. At any rate the most careful attention should be given to the relation of all such discoveries to the drift of the region in which they occur.

A few of the other evidences of palæolithic man in Minnesota may be mentioned. Dr. A. E. Johnson mentions in the Bulletin of the Minnesota Academy of Natural Sciences for 1874, the discovery of human bones in the sand and gravel of the Mississippi river in

the eastern terrace bluffs, at Minneapolis, coincident in age and hight with the terrace bluff in which the quartz chips occur at Little Falls, this being a deposit coincident with or immediately following the last glacial epoch. On the same authority two fragments of a human lower jaw with teeth were discovered in the "red clay and boulder drift" near the Falls of St. Anthony, by workmen excavating in it for use in the tunnel under the river, lying "immediately upon the limestone ledge." This red clay is the product of the first, or oldest known, glacial epoch, and lies below all the other drift. He also states that on the same side of the river a copper spear-head was taken from a crevice in the limerock of the Lower Trenton, where its strike forms an elevation in the alluvial plain of the terrace above mentioned, at some distance from the immediate river, under four feet of drift—"sand, gravel and clay"—which is now in possession of the St. Paul Historical Society. This deposit is of the same plain and date, as the material of the terrace containing the quartz chips. The spear-head is said to have been three feet within the lime-rock. It must be admitted, however, that, supposing these human bones and teeth to have been found in the manner reported, they may still have been the result of more modern burials, and the spear-head may have been thrust in the crevice (a weathered and eroded jointage-plain) horizontally, instead of perpendicularly, as these open crevices abound in the Lower Trenton and appear on the exposed wall of the rock facing the river, and especially in that part of the ancient channel which was cut prior to the last glacial epoch, where this spear-head was found. The locality of the Falls must always have been a resort for rude tribes of men, and a great many burials, not to say battles, may have taken place here. Still there is an appearance of authenticity about these discoveries, so far as the published facts go.

A stone axe weighing six pounds was found at St. Paul in digging a cellar near the Adams school house, by Jacob Biska, six or eight feet below the surface. It was overlain by soil and black loam, which has a thickness of eight or ten feet at that point. The figure below shows its outline. The surface of the blade end is smoothed, or roughly polished, but the other end is rougher, or weather-worn. This lay in the latest of the drift deposits, but far beyond the reach of the present river, though within the outer drift bluffs.

FIG. 8.




Stone axe and disc found at St. Paul.

In a gravel bank at St. Paul also was found recently by Mr. Mervine, a stone disc about two inches in diameter, and three-quarters of an inch in thickness. This has a circular depression in the center. One side is coated with a limy crust. It is of a fine-grained greenstone.

The remains of an extinct elephant, in the form of a tooth and tusk, were found in the gravel and sand of the east bank of the Mississippi about five miles above Minneapolis. These occupy the same relation to the river and the valley as the quartz chips at Little Falls, having been taken from the same terrace.

In the coarse river-gravel at Stillwater, far above the present river, but within the main valley, was found a mastodon's tusk, and about eight feet of it are preserved in the Academy of Sciences at St. Paul. This was taken out in the year 1856 by A. Van Vorhes. The section of the bank in which it was found is now made up as follows:

1. Disturbed sand with some boulders .................... 5 feet.
2. Fine sand, with nearly horizontal strata .................... 2 to 6 feet.
3. Gravel and boulders .................... 0 to 4 feet.
4. Very fine, handsome sand, in horizontal stratification .... 15 feet.
5. Coarse gravel and boulders .................... 4 to 6 feet.
6. Horizontal strata of fine sand .................... 30 to 40 feet.
7. The "tripoli" bed lies next below this fine sand.

The tusk was found in No. 6, and near the bottom. Near the top of the same stratum, Mr. Van Vorhes found fragments of pottery having carving and ornamentation. These are all to be seen in the Academy at St. Paul.*

In the possession of the Minnesota Historical Society are two immense stone hammers recently obtained at St. Peter by Mr. B. M. Randall. One of these was found four feet under ground, and the other was on the surface. They each weigh fifty or sixty pounds. The adjoined sketch of their probable manner of use represents, if correct, probably the most primitive flouring-mill that Minnesota ever possessed. It was prepared by Dr. R. O. Sweeny. While these millstones each have a groove running about them, somewhat on one side of the middle, as if for receiving a withed frame, yet the groove of one appears as if it were of natural origin, and caused by the more rapid disintegration of a vein of micaceous granite or gneiss with which the groove is coincident, while the bulk of the stone is of a firmer rock. In the other, however, the groove has evidently been dug out by coarse artificial chipping.

These *upper millstones* were found at points two miles separate. One, the larger of the two, has the groove deep on one side, but less

*The importance of this "find" caused the writer to distrust his own notes, made in 1872, as to the exact position of the pottery, although taken down on the spot as described by Mr. Van Vorhes, and to make a fresh application to Mr. Van Vorhes for the particulars as to its *exact position*. The following from that gentlemen, who is an experienced surveyor and an exact observer, affirms the position of both as at first stated:

STILLWATER, April 26, 1877.

DEAR SIR:—Yours of the 16th came duly to hand, and found me almost helpless with a rheumatic attack, which explains my seeming neglect to answer your inquiry.

The mastodon tusks were found about eight or ten feet above the base of the hill: the hill at this point rises at an angle of about 45°. After excavating in the base of the hill on the grade of Myrtle street about 37 feet, the tusks were found, consequently 37 feet below the surface. At this point the hill was about 90 feet high.

The crockery I found some thirty feet farther into the hill and some six or eight feet higher in the strata. This hill is a continuous tongue of land lying between the Florence mill stream and a spring run. The two streams run parallel and some 350 feet apart. The hill is so steep on the Florence mill side as to be inaccessible except by clinging to roots and brush growing on it. The material at the base is sand and small gravel. Where the tusks were found the strata were pure sand ten or twelve feet thick, exhibiting clearly the direction of the current in an eastward inclination one or two degrees. On the top of the hill were heavy boulders of the drift period. I deeply regret that indisposition and the weight of eighty-four years have rendered me incapable of composing a satisfactory communication. Yours, with much esteem,

A. VAN VORHES.

noticeable on the other, and was found in 1876. It lay "under the ground, covered with black earth and sand, above a layer of chalky deposit containing some flint and other stones." It was on the rocky terrace formed by the Shakopee and Jordan formations near St. Peter, but a little south of the town, and thirty rods distant from the flood plain of the Minnesota river. The smaller one was found "two miles further south, just at the foot of the bank, among a lot of boulders of all sizes." It was found in August, 1874.

FIG. 9.


Primitive flour-mill and outlines of the upper millstones.

The phenomena of the mounds that are scattered all over the State cannot be regarded as palæolithic, since they pertain to a period subsequent to the last glacial epoch. The mounds are found indiscriminately at all levels, and in all relations to the drift deposits—even on the latest deposits. Remains that are found embraced within the actual drift, are classed here, according to Mr. James Geikie, as palæolithic. If they are in the gravel or sand along rivers or in the hardpan of the last glacial epoch they accompanied or preceded the last glacial epoch. If they are in the hardpan of the first glacial epoch they have a still older date. Under this grouping neolithic remains are only those of later date than the last glacial epoch.

*The Soil of Morrison County.*

The immediate river valley is rather sandy, and has reacted against the settlement of the county: but the general level of the country, away from the river, is of a very different character. There is a fine red loam that covers much of the land east of the river, which is of the same nature and date as the loam that is spread over the uplands in much of the southeastern portion of the State, and has given that section of the State a notoriety for ease of culture and fertility of soil, second to none in the United States. This loam in some places is rather coarse. It is, indeed, seldom clayey, as it is in Houston County, and in other places it is wanting, the soil then being a gravelly hardpan, or gravelly clay. The eastern portion of the county is mainly one of plain, or rises and falls in broad undulations, the valleys being occupied by the creeks that generally drain southward, or toward the Mississippi. On the west side of of the river the alluvial plains are wide, and are rather wet now, but they are destined to be drained, which can easily be done, when they will be found to possess some of the best soils in the county. The hardpan that closely underlies these flats sometimes appears in low knolls which have already been taken by settlers, as they rise slightly above the flats and furnish a different forest growth; while back of the flats is a series of drift bluffs furnishing heavy hardwoods, which correspond with the bluffs on the east side of the river. These bluffs introduce a belt of hardpan clay soils, and continue westward, through slight variations, to the Leaf Hills. Throughout this range, and scattered over the intervening surface, are frequent boulders of granite and of northern limestone.

*Water Powers.*

There is a fine water-power in the Mississippi at Little Falls, and a rocky island in the river makes its improvement more feasible. This was used at one time for milling and manufacturing purposes, but the dams have been swept out by the river, and the buildings themselves are entirely destroyed. The recent completion of the railroad north and south through the county, running on the east side of the river, is destined to hasten the settlement of this interesting county, and to develop more rapidly its great natural resources.

There are flouring mills already established at the following points:

On the Platte river, Sec. 35, Belle Prairie; three runs of stone, for custom work; also has machinery for cutting lumber. This is known as Grevel's mill.

Hill Brothers' mill is at the mouth of the Little Elk river and manufactures flour and lumber. It has two runs of stone. and 12 feet water head.

# V.

# THE GEOLOGY OF RAMSEY COUNTY.

### *Situation and Area.*

Ramsey county lies east of the Mississippi and embraces St. Paul, the Capital of the State. It contains 101,124.62 acres. It is nearly rectangular, but is indented on the south by a great northward bend in the Missippi river. On this bend St. Paul is situated. The following tabulated statistics show the areas of the different towns, and dates of survey. The territory here described as lying south of the Mississippi river was detached from Dakota county and added to Ramsey county by an act of the Legislatnre, approved, March 9th, 1874. The county has Hennepin and Anoka on the west, and Anoka on the north. Washington county, about eighteen miles wide separates it from Lake St. Croix, which is the eastern boundary of the state; separating it from Wisconsin:

## SURVEYING STATISTICS OF RAMSEY COUNTY,

*By F. E. Snow.*

| Township. | Range. | Township Lines. | | Subdivisions. | Acres. | Remarks. |
|---|---|---|---|---|---|---|
| | | When Surveyed. | | When Surveyed. | | |
| 28 | 22 | S. & E. | September, 1847 | October, 1847 | 7,785.31 | North of Miss. River, Sections 24, 25, 35 and 36 lie in Washington County |
| 28 | 22 | N. & W. | October, 1847 | ........ | ........ | ........ |
| 28 | 22 | S. & W. | July, 1853 | September, 1853 | 2,475.62 | South of Miss. River. Includes Sections 4, 5, 6, 7, 8 and 9, except the S. W. ¼ of S. E. ¼ of Section 7 |
| 29 | 22 | N. E. S. & W. | October, 1847 | November, 1847 | 22,467.09 | ........ |
| 30 | 22 | S. E. & W. | October, 1847 | December, 1847 | 19,270.98 | ........ |
| 30 | 22 | N. | August, 1847 | ........ | ........ | ........ |
| 28 | 23 | N. & E. | October, 1847 | October, 1847 | 8,158.17 | North of Mississippi River |
| 28 | 23 | E. & S. | July, 1853 | August, 1853 | 168.37 | South of Mississippi River, Section 12 |
| 29 | 23 | N. E. W. & S. | October, 1847 | November, 1847 | 18,917.87 | Sections 6, 7, 18, 19, 30 and 31 of this township lie in Hennepin County |
| 30 | 23 | S. E. & W. | October, 1847 | December, 1847 | 21,881.21 | ........ |
| 30 | 23 | N. | August, 1847 | ........ | ........ | ........ |
| | | Total area of Ramsey County | | | 101,124.62 | |

*The Surface Features.*

With unimportant exceptions the northern third portion of the county is flat while the remainder is rolling or hilly, becoming more and more broken toward the Mississippi river. Thus rolling surface in the southern portion is due to the present *pose* of the drift materials, and not to any upheaval in the rocks. The rocks everywhere lie practically horizontal, but they have been eroded by streams in numerous instances, prior to the drift-epoch, so that there are deep valleys in the rocky surface. These valleys materially modified the manner of deposition of the drift, and determined its composition at special points. The drift materials seem to have been accompanied by more water, in the act of deposit in the level, northern portion, than in the southern, and have also, since their deposit, been smoothed off by the same agency, during the prevalences of a second glacial epoch. The loam that is spread over the most of the county is the sole product, in the most of Ramsey county, of this second glacial epoch, but it was spread by water instead of ice. Where the old drift clay is visible in the northern part of the county it appears as gravelly ridges rising slightly above the flat country round about, and is then but very slightly covered with the loess loam. This loam, however, is conspicuous and abundant over the most of the county, particularly in the eastern portions.

The Mound View Hills, in Mound View township, afford the most important instance of the prevalence of the old hardpan drift above the general flatness of the country in that part of the county. They are in Secs. 10 and 15, T. 30 N. R. 23 W. They rise about 100 feet abruptly above the valleys which separate them, and about 200 feet above Rice creek valley. They consist outwardly of red gravelly hardpan, but they probably have a nucleus of harder rock. Their remoteness from the main belt of the Trenton makes it less likely that their rocky nucleus is of that formation. The Potsdam sandstone, as a quartzyte, rises in monoclinal hills in other parts of the State round the areas of the St. Peter, and forms several such rocky knobs. In this case, if this quartzyte be the cause of these hills, the original rocky knobs served as gathering places for a greater abundance of morainic drift. For further illustrations of similar phenomena in Minnesota the reader is referred to the Second Annual Report p. 193. This series of knolls does not extend far in any direction, their principal elongation being N. and S. There are three principal hills. They are scantily timbered with Burr Oak. The lands about have comparatively but few Burr Oaks.

*Natural Drainage.*

The most of the county is drained southwardly into the Mississippi. But the streams are small, and expand into lakes at frequent intervals. In the northern part of the county, where the most of these lakes are situated, there is less diversity of surface, and sometimes the streams, and the lakes themselves, are skirted by extensive marshes or "hay meadows." In the northwestern part of the county the natural drainage is toward the northwest, and reaches the Mississppi through Rice creek. The Mississippi river, which runs along the southern boundary of the county, lies in a deep valley which is about two hundred feet below the general upland. The streams which enter it generally pass down this descent gradually at points several miles distant from the river itself. But above Fort Snelling the streams enter it abruptly, by plunging over the perpendicular bluffs of rock, by wbich the river is everywhere enclosed.

The lakes of the county are, some of them, large and deep, and contain pure and clear water. They have low shores, and are but little below the general level in the northern part of the county, but in the southern they are in deep basins in the general surface, having gravelly shores and frequently attractive natural surroundings. White Bear Lake in the northeastern part of the county, and Lake Como, near St. Paul, are the chief of these lakes that serve as summer resorts; though there are several other large, and perhaps equally pleasant, in the central part of the county. Some of these lakes are united by the St. Paul water works, and supply the city of St. Paul, through Lake Phalen, with water for public and domestic purposes. This line of water works, by means mainly of artificial connections, takes its supply from Pleasant Lake, passes through Vadnais Lake (connecting here also with the waters of Bass, Lambert's and Goose lakes), enters Gervais Lake, then Spoon Lake and finally discharges from Phalen Lake through an acqueduct, into St. Paul. Thus an artificial water-course is established from the northern to the southern boundary of the county—Rice lake, the most distant with evident connection, being on the northern boundary, partly within Anoka county.

The water that issues at Fountain Cave, St. Paul, is that of a creek which disappears in the ground about half a mile distant—toward the city.

The knolls themselves are evidently "kames," and in studying their cause all the problems of the glacial epoch are brought before the mind. They are now supposed to have been formed, so far as the drift is concerned, in the beds of streams of water running on and through the ice, and in openings like great crevasses formed by the underlying rocky knobs, as the ice-sheet passed over them. These hills are conspicuous objects in the horizon from distant points in all directions. They are visible from the high land in Reserve township, Sec. 16, T. 28 N. R. 3 W., and from their summits can be seen Anoka, Hamline University, the Reform School, the spires and smokes of Minneapolis, some of the buildings of St. Paul, and the village of Centerville. This view is more extensive, but not so interesting as that on the peninsula on Sec. 16, Reserve, from which point these hills can be seen, and a fine view can be had over the valleys of the Minnesota and Mississippi covering Fort Snelling and Minneapolis at nearer range.

There is another cluster of lower clayey and gravelly ridges in the northwestern part of White Bear Township, and an outlying area of Upper Trenton, causing a high tract in the southern part of the same township.

The southern part of the county, mainly occupied with the Trenton formation, is generally higher than the northern. The drainage courses which pass through it toward the Mississippi lie in deep valleys, which are surrounded and hid by hills and ridges of drift. These hills probably are due primarily to a rock-sculpture, older than the drift, but the drift is so thick that the rock seldom appears in exposure above the surface. There is some appearance of the former extension of the valley of Rice Creek much further southward, and it is no unreasonable suggestion that the great Mississippi itself may have once occupied this valley, entering the great gorge again where it becomes remarkably widened at St. Paul; but the evidence is entirely topographical. Such as it is, it is perhaps over-balanced by a confusion of hills and high drift-ridges north of St. Paul, which render it improbable that the Trenton is anywhere entirely cut through from the Rice Creek valley to St. Paul, as would have been the case if the Mississippi ever passed through there. Other evidences of this hypothetical position of the Mississippi north of St. Paul are mentioned under the head of Drift.

*Description of the Towns of Ramsey County.*

T. 28 N. R. 22 W. (*Fractional*) *S. part of* McLean *and part of* St. Paul.

This town shows the extremes between high rolling or hilly land and low alluvial flood plain. The bluff portion east of the Mississippi is about a mile and a half wide and three miles long, running north and south, and is cut by east and west valleys and by tributary creeks, so as to have a rough or hilly surface. It is considerably more than half covered with small timber (oaks and aspens.) The rest of this town east of the river is low, and largely occupied by hay meadows or by marsh. A belt of soft timber growing to large dimensions, separates it from the river channel. On the west side of the river there is a repetition of these features, but in reverse order. W. St. Paul is embraced in this portion. Area in Ramsey County 10,260.93 acres.

T. 29 N. R. 22 W. New Canada, *with N. part of* McLean *and N. E. part of* St. Paul.

This town has a rolling or hilly surface, and is about half covered with timber. Toward the north it is more flat. Through the central portion passes the canal of the St. Paul Water Works and Phalen's Creek. It has several large lakes and also several marshes, but the most of the town is arable agricultural land. Area, 22,467.09 acres.

T. 30 N. 22 W. White Bear.

This town is mainly flat, and embraces a greater water area than any in the county. It also has several large marshes in the northern and central portions. It has a small area of more elevated land in the northwestern corner, east of Pleasant Lake, and another in the southwestern, south of White Bear Lake. The subsoil is a gravelly clay, which sometimes rises to form also the soil, but the surface soil is usually either a sandy loam, which sometimes becomes too light for good farming, or is a clay with a flat surface. Area, 19,270.98 acres.

T. 28 N. 23 W. (*Fractional.*) Reserve, *and W. part of* St. Paul.

This town has a rolling and generally a gravelly clay surface, and is either timbered with small oaks and aspens, or is of rolling prairie. It is diversified on three sides by the bluffs of the Mississippi. It contains no lakes and but few marshes. Area, 8,326.54 acres.

### T. 29 N., 23 W. (*Fractional.*) ROSE, *and N. W. part of* ST. PAUL.

The southern part of this town is high and rolling, with a red clay subsoil. The northern part is more sandy and flat, embracing the portion round Lake Josephine and the southern part of Big Bass Lake. It also contains Lake Como, with a number of other minor lakes, with several marshes. These are mainly in the northern portion. Sections 16, 17, 21 and 22 are mainly of prairie. The rest of the town is well timbered. Area, 18,917.87 acres.

### T. 30 N., 23 W. MOUND VIEW.

The hills already described, near the center of this town, give it its name. Aside from these hills and a tract along the S. W. corner, the whole town is flat or gently undulating, and has a rather sandy soil. This sand, however, is closely underlain by an impervious clay, as evinced by the numerous lakes and marshes which are found within its limits. Rice Creek is a slow, crooked stream, frequently skirted with marshes or hay meadows. The town is somewhat more than half covered with small oaks, with aspens and elms in the low grounds. Area, 21,881.12 acres.

### *Elevations in Ramsey County.*

| | Above the Ocean. |
|---|---|
| Lowest known water in the Miss. R. at St. Paul | 676 feet. |
| Highest known water in the Miss. R. at St. Paul | 697 feet. |
| Summit between White Bear Lake and St. Paul (8 feet cut), according to the St. Paul and Duluth R. R. | 959 feet. |
| Junction at White Bear Lake, St. Paul and Duluth R. R. | 920 feet. |
| St. Paul and Pacific Depot, St. Paul | 689 feet. |
| Base of the Capitol, St. Paul | 782 feet. |
| Bluffs back of the Capitol, head of Robert street | 901 feet. |
| Summit avenue bluff | 910 feet. |
| Junction of the St, Paul and Pacific and the St. Paul, Stillwater and Taylor's Falls R. R.'s | 762 feet. |
| Crossing of the St. Paul and Duluth and St. Paul, Stillwater and Taylor's Falls R. R.s | |
| Grade of St. Paul and Duluth R. R. | 817 feet. |
| Grade of St. P., S. & T. F. R. R. | 797 feet. |
| Grade of the Mil. & St. P. R. R. at Dayton's Bluff | 696 feet. |

### *Soil and Timber.*

The southern half of the county has a clayey subsoil, with a clayey lœss-loam overspread; and in general the northern, more flat, portions have the same subsoil, with a sandy lœss-loam over-

spread. There are, however, many spots where the lœss-loam is thin or wanting, where the subsoil constitutes also the soil; but in the southern rolling portions this circumstance is likely to afford a clayey soil, while in the northern this clay is more gravelly. Along the Mississippi River is a large area of alluvial land, which is so wet that it cannot be depended on for general farming, but furnishes a great deal of wild hay. There are also some higher flats along the river that are very fine for farming. The county, however, is not generally occupied for farming, but is owned by non-residents.

The following species of trees and shrubs were noted in the examination of the county.

Quercus coccinea. *Wang.* Var. tinctoria. *Bartram.*

[NOTE.—This is the tree that has been named *Quercus rubra L.* with doubt, in former reports. It is what is known oftenest as "Black Oak," but also is called "Quercitron," and "Yellow Barked Oak." Careful observations were made in the survey of this county on this oak. There was a specially favorable opportunity in West St. Paul, where were seen evidently two species, of oak, the black and the red, yet nearly alike, growing in a ravine in the same situation. This was near the "Farmer's Hotel" on the E. side of the street. They were here in company with white oak. The two species here growing under the same circumstances showed constant differences. Several trees here, of each, are of about the same size, but small. The general habit and color of the two are the same, except that the red is more open-branched, and looser in the top, having fewer dead twigs and branches. The chief distinctions are in the leaf and fruit. The red-oak leaf has the same general shape, and the same number of toothed lobes as the black, but the central undivided portion is wider than in the black, and the whole leaf is longer in proportion to its full width; hence its foliage is coarser and heavier than in the black. The leaves of the red droop, while those of the black turn easily with the wind, and stand in all positions. In the fruit, the acorn of the red is double the size of that of the black, both growing on last year's wood; the acorn of the red rising three or more times the hight of the shallow cup, while that of the black only rises about twice the hight of the cup. The cup of the red is generally an inch across; that of the black about half an inch or a little more.

This is by far the most abundant oak in the county, as it is throughout the southern half of the State; but there are some situations, particularly exposed, high hillsides, like the tops of Mound View Hills, in which it is noticed to fail, though growing abundantly

on lower levels, and to be replaced by the Bur Oak. It does not frequently appear as a large tree, but is generally less than ten inches in diameter, or simply has the size of shrubs, intermixed with Bur Oaks of the same size.]

Quercus rubra. *L.* Red oak.

[NOTE.—At present this oak must be restricted to the only point at which it has been identified, *viz.* West St. Paul.

Quercus macrocarpa. *Michx.* Bur Oak.
Quercus alba. *L.* White Oak.
Ulmus Americana. *L.* (Pl. Clayt.) Willd. American Elm.
Populus tremuloides. *Michx.* Aspen.
Populus grandidentata. *Michx.* Great-toothed Poplar.
Populus monilifera, *Ait.* Cottonwood.
Tilia Americana. *L.* Bass.
Negundo aceroides. *Mœnch.* Box Alder.
Juglans cinerea. *L.* Butternut.
Carya amara. *Nutt.* Bitternut.
Fraxinus Americana. *L.* White Ash.
Fraxinus sambucifolia. *Lam.* Black Ash.
Acer rubrum. *L.* Red Maple.
Acer saccharinum. *Wang.* Sugar Maple.
Betula alba. *Var.* populifolia. *Spach.* (?) White Birch.

[NOTE.—About some of the lakes becomes 12 and 14 in. in diameter.]

Larix Americana. *Michx.* Tamarack.
Juniperus Virginiana. *L.* Red Cedar.

[NOTE.—Large trees grow at Lake Johannah, and also along the rocky bluffs of the Mississippi.]

Salix nigra. *Marshall.* (?) (And other willows).
Ulmus fulva. *Michx.* Slippery Elm.
Prunus serotina. *Ehr.* Black Cherry.
Pinus Strobus. *L.* White Pine.

[Only along the banks of the Mississippi above Fort Snelling.]

Betula excelsa, *of American authors.* Gray Birch.

[At Lake Johannah.]

Prunus Pennsylvanica. *L.* Small Red Cherry.
Prunus Americana, *Marsh.* Wild Plum.
Zanthoxylum Americanum. *Mill.* Prickly Ash.

Ostrya Virginica. *Willd.* Ironwood.
Carpinus Americana. *Michx.* Water Beech.
Prunus Virginiana. *L.* Choke Cherry.
Amelanchier Canadensis. *Torr and Gray.* Juneberry.
Pyrus coronaria. *L.* American Crab Apple.
Rubus occidentalis. *L.* Black-Cap Raspberry.
Rubus strigosus. *Michx.* Red Raspberry.
Rubus villosus. *Ait.* High Blackberry.
Ribes Cynosbati. *L.* Wild Gooseberry.
Ribes rotundifolium. *Michx.* Smooth Wild Gooseberry.
Ribes lacustre. *Poir.* (?) Swamp Gooseberry.

[Has a smooth fruit in racemes.]

Sambucus Canadenses. *L.* Elderberry.
Spiræa opulifolia. *L.* Ninebark.
Spiræa salicifolia. *L.* Meadowsweet.
Celtis occidentalis. *L.* Hackberry.
Alnus incana. *Willd.* Speckled Alder.
Alnus serrulata. *Ait.* Smooth Alder.

[NOTE.—Both alders are found, often in company, on the flats about White Bear Lake, but the smooth rarely exceeds three feet in hight, the other being ten or fifteen.]

Amorpha canesceus. *Nutt* Lead Plant.
Amorpha fruticoso. *L.* False Indigo.

[This has very much the appearance of a small locust.]

Aristolochia Sipho. *L'Her.* (?) Pipe Vine.
Rhus glabra. *L.* Smooth Sumac.
Rhus typhina. *L.* Staghorn Sumac.
Rhus Toxicodendron. *L.* Poison Ivy. (Tuttle Lake.)
Vitis cordifolia. *Michx.* Frost Grape.
Symphoricarpus occidentalis. *R. Br.* Wolfberry.
Corylus Americana. *Walt.* Hazel.
Cornus florida. *L.* Flowering Dogwood.
Cornus sericea. *L.* Silky Cornel.
Cornus alternifolia. *L.* Alternate-leaved Cornel.
Cornus paniculata. *L'Her.* Panicled Cornel.
Ceanothus Americanus. *L.* Jersey Tea.
Vaccinium corymbosum. *L.* *Var.* amœnum. Swamp Blueberry.
Lonicera parviflora. *Lam.* Small Honeysuckle.
Celastrus scandens. *L.* Bittersweet.
Ampelopsis quinquefolia. *Michx.* Virginia Creeper.
Rosa blanda. *Ait.* Early Wild Rose.
Viburnum Opulus. *L.* Highbush Cranberry.
Cornus stolonifera. *Michx.* Red-osier Dogwood.
Cratægus coccinea. *L.* Thornapple.

There is but little heavy timber in the county; yet it is nearly all covered with small trees and shrubs. The uplands and the flat parts of the county are furnished with black and bur oaks and poplar. The rest of the above species of trees are found in exceptional situations, as along the shores of lakes or streams, or in the flood plain of the Mississippi river. Several species are also peculiar to the rocky bluffs.

## THE GEOLOGICAL STRUCTURE.

The formations that will here be described, embraced within the county, are as follows:

1. The St. Peter Sandstone.
2. The Lower Trenton Limestone.
3. The Green Shales.
4. The Upper Trenton.
5. The Drift.
6. The Loess Loam.

The St. Peter Sandstone underlies the northern flat and sandy portion of the county and the alluvial portions along the Mississippi, outcropping in the bluffs.

The Lower Trenton is that quarried at St. Paul, and its area is not distinctly separable from that of the other three members of the Trenton. These, taken together, underlie the hilly and clayey parts round St. Paul and extend in diverging arms, one toward the northeast and one towards the northwest. Between these arms, which embrace all three parts, is an area which includes the northwestern parts of New Canada and the northeastern parts of Rose townships, that is probably underlain only by the Lower Trenton. All of these members underlie the township of Rose in general, and the eastern part of New Canada. They would also be found in the high portions of the eastern part of McLean. The key to this distribution is found at St. Paul, and in the hills south of White Bear Lake, where certain features of the topography are found to coincide with their presence, and another set of topographical features to prevail in their absence. These topographical indications are almost the sole guide in thus assigning the parts of the Trenton to different parts of the county, on account of the abundant drift with which the county is covered.

*The St. Peter Sandstone.*

This sandstone is seen in the bluffs of the Mississippi from Fort Snelling to the southeastern corner of the county; and by reason of the breaking down of the overlying Trenton wherever former drainage streams have run, and the easy erosion of this rock, it also becomes the surface rock in a number of tributary valleys. In the city of St. Paul there is a large expansion of the St. Peter area over the low level through which Phalen's creek, and others, enter the Mississippi, which extends more than a mile north of the river. Further south are several such re-entrant areas in McLean township. The wide bottom-land east of the river, in McLean township, is represented on the geological map of the county, as St. Peter, but it is possible that the Shakopee limestone, which is shown at Red Rock, some further south, extends as the surface rock within Ramsey county, under the alluvium of the floodplain, but it is nowhere visible. At the most it can occupy but a small area. The St. Peter is about 150 feet thick. It has no noteworthy variations of character, as far as seen in Ramsey county, and it has already been described so many times that its lithological features need not be delineated again.

*The Lower Trenton.*

This is what Dr. Owen styled "St. Peter's Limestone," in his final report on the Geology of Wisconsin, Iowa and Minnesota, and which Dr. B. F. Shumard divided into:—

| | | |
|---|---|---|
| 1. Upper Shell limestone. | F. 3. c........................ | 6 ft. |
| 2. Non-fossiliferous Bed. | F. 3. b........................ | 5 ft. |
| 3. Lower Shell limestone. | F. 3. a............. ......... | 23 ft. |

In later reports, particularly those of the Wisconsin geologists, they were designated as the "Buff Limestone," and the "Blue Limestone," the former lying below the latter. These terms, however were strictly applicable only to formations in Wisconsin, but by inference were extended to cover the geological horizon at St. Paul and the Falls of St. Anthony. The Blue Limestone, however, of northern Wisconsin seems to have been regarded by Dr. Lapham as the equivalent of the Hudson River Group, of New York, and also of a formation of the same name in Ohio, where the term originated, and supposed to lie entirely above the proper Trenton.* These

* When this term was originally applied to the Ohio rocks they were regarded as a continuation of the Trenton limestone of New York.

terms seem still the more inapplicable to the limestones seen at St. Paul and St. Anthony Falls, since the terms "buff" and "blue" should be in reverse order. The "Lower Shell limestone" is more frequently blue than the Upper Shell limestone, and is always so on fresh quarrying. The latter is rather a dirty gray or drab, appearing somewhat like a fine-grained sandstone, and is often harsh to the touch.

Later still the whole of the limestone exposed at St. Paul was classed by Prof. James Hall as the equivalent of the Wisconsin "Buff Limestone," the "blue limestone" being some higher member not distinctly recognized in Central Minnesota, but in the light of further observations now known to be what has been designated by this survey as the "Upper Trenton," at its chief exposures in the southern part of the state, but which has not until the present been discovered as far north as St. Paul. At the same time (Geology of Wisconsin, Vol. I, p. 33.—1862.) Prof. Hall regards the Buff Limestone as the equivalent of the New York "Birdseye" and "Black River" limestone. In the meantime, the "Blue Limestone" in Ohio has become enlarged into the "Cincinnati Group," and the Trenton in that state involved so closely with it that its identity is nearly or wholly lost. On the west of the Mississippi, however, the Trenton has been shown to have a full development, and even to take on a peculiar phase designated "Galena," while the aluminous phase so largely developed at Cincinnati has only been recognized in the "Maquoketa Shales" of Dr. White.

Still more recently Prof. Chamberlain, of the Wisconsin survey, has shown (Geology of Wisconsin, Vol. II, 1873-77) that the lithological differences commonly relied on to distinguish the "blue" from the "buff" are not general nor reliable; that there is no chemical distinction which holds good, and that the fossils of the "buff," as heretofore limited, are also to be found above the "blue." Hence he regards them as essentially one. Further, in the northern part of the State he states that even the *Cincinnati Shales and Limestones* are undistinguishable by any satisfactory line of demarkation from the Trenton limestone, and includes that with the rest, under the general term "Trenton Group."

With these preliminary remarks it will be understood that the term *Lower Trenton* is not supposed to convey any greater significance than an appropriate designation for a local lithological phase, by which the lower part of the great Trenton Group is easily distinguished from the rest in the state of Minnesota.

Wherever the base of the Trenton has been seen in Minnesota, it has been found to consist of about 25 feet of calcareous firm

beds (sometimes with some shaly layers), which give great prominence to this geological horizon in the topographical effects which they produce. They are underlain by an erosible sandrock, and overlain by a varying thickness of green shale. The underlying sandrock crumbles away, letting the limerock project, but the overlying shale sheds the surface waters that would otherwise disintegrate the limerock. These combine to preserve the limerock and to cause it to project in long, prominent headlands, and to form the brows of ridges and terraces which diversify several counties in the southeastern part of the state. The thickness of the overlying shale has heretofore not been supposed to exceed twenty feet, but observations made in Ramsey county go to show that the whole upper Trenton, so called in the southern part of the state, is here changed to a calcareous shale, with thin limestone layers, perfectly comparable to the Cincinnati shales and limestone of Ohio.

In Ramsey county this lower Trenton, or "Buff" limestone, as Dr. Owen at first designated it, is separable into three parts which have pretty constant characters, and they are approximately as given above from Dr. Shumard.

1. Impure, harsh, drab or dirty buff limestone, containing lumps of calcite and species of *Strophomena* and *Orthis*, with other fossils.......................................... 6–10 feet.
2. Shale, and calcareous shale with fragments of fossils..... 6–10 feet.
3. Limestone, with aluminous partings. This is the building stone of St. Paul. The mingling of shaly and calcareous parts throughout this limestone causes the dressed surfaces of large slabs to have a blotched or mottled surface, particularly when the dressed side coincides with the natural bedding. This member is the most persistent of the Lower Trenton, but splits into thin layers on long exposure, due to the loosening of the shale throughout the mass. This contains fossils characteristic of the Trenton, but generally in fragmentary condition............... 15 feet.

Besides the three main parts above described there are also several thin beds of green shale in No. 1, which seem not to be confined to any definite horizon, and nearly always a layer of green shale below No. 3.

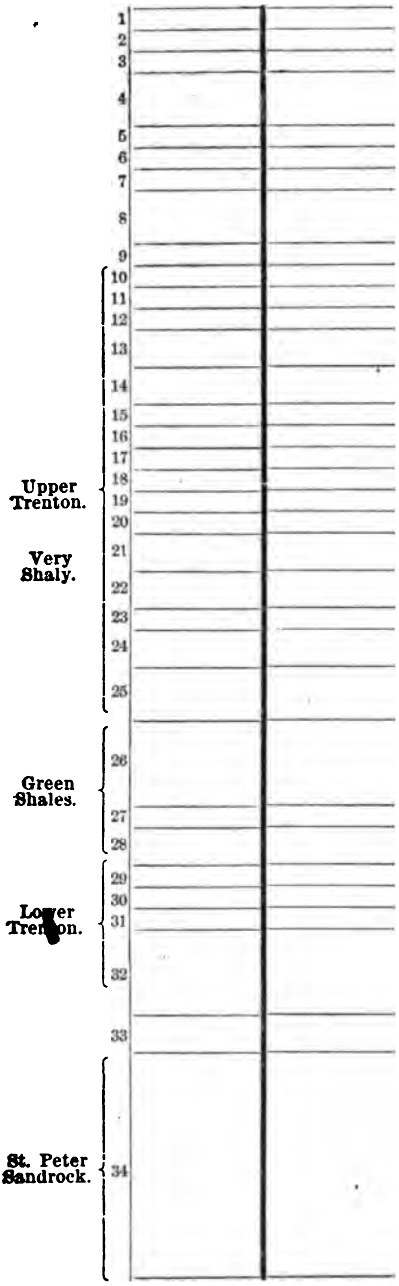
In sections of the bluffs at St. Paul given in Dr. Owen's final report, this limestone is represented as greatly broken and even faulted along the river from Fort Snelling to St. Paul and especially in the vicinity of New Cave (now known as Fountain Cave) near the railroad bridge of the Milwaukee and St. Paul R. R. This locality was specially examined. The layers of the limerock are, it is true, disturbed along the immediate river bluff and are mixed in some

confusion with coarse drift, but at points further from the river the beds continue along horizontal and unbroken, so that the formation itself cannot be said to be disturbed. Dr. Owen attributes rightly this broken condition, so far as the blocks seem to lie on drift materials, to the action of water, and probably that of the river at some higher stage. The beds were undermined and dislodged, but were not transported. Probably floating masses of ice, during the last glacial epoch which did not extend as a continuous ice-sheet east of this place, in Minnesota, played an important part in displacing these limestone blocks, and in depositing among them the water-worn drift.

*The Green Shales and Upper Trenton.*

The first intimation of the existence of any rock *in situ* in Ramsey county, above the Green Shales as they have been described in counties further south, and in Hennepin county, was found in the drilling of the well at the State Reform School near St. Paul. This was ordered by the legislature of 1877, and was done by C. E. Whelpley of Minneapolis. Mr. F. McCormick, Secretary of the State Reform School, has furnished the following:

## *Notes of the Deep Well Bored at the State Reform School, in the Months of April and May, 1877.*




| | Feet. |
|---|---|
| 1. Two feet black soil.............. | 2 |
| 2. Three feet gravel............... | 3 |
| 3. Six inches clay.................. | 0½ |
| 4. Thirteen feet coarse gravel..... | 13 |
| 5. One foot fine sand .......... | 1 |
| 6. One foot coarse gravel ........ | 1 |
| 7. One foot fine sand.... ......... | 1 |
| 8. Thirteen feet coarse sand...... | 13 |
| 9. Two feet boulders..... ......... | 2 |
| 10. Three inches lime rock......... | 0¼ |
| 11. Three feet clay.................. | 3 |
| 12. Two feet sand, with water...... | 2 |
| 13. Six feet three inches shell rock with clay...................... | 6¼ |
| 14. Seven feet hard lime rock...... | 7 |
| 15. Two feet clay........ ........... | 2 |
| 16. One foot hard rock.............. | 1 |
| 17. Four feet blue clay.............. | 4 |
| 18. Four feet hard rock............. | 4 |
| 19. One foot blue clay ............. | 1 |
| 20. Three feet lime rock............ | 3 |
| 21. Six feet clay light color........ | 6 |
| 22. Five feet clay, dark color...... | 5 |
| 23. Four feet yellow clay........... | 4 |
| 24. Five feet blue clay.............. | 5 |
| 25. Eight feet blue clay (very hard). | 8 |
| 26. Twenty-eight feet blue clay.... | 28 |
| 27. One foot lime stone (hard)...... | 1 |
| 28. Six feet blue soap stone........ | 6 |
| 29. Three feet lime rock............ | 3 |
| 30. Three and one-half feet blue soap stone......... ........... | 3½ |
| 31. One and one-half feet lime rock | 1½ |
| 32. Twenty-eight and one-half feet blue lime stone................ | 28½ |
| 33. Five feet blue clay.............. | 5 |
| 34. Seventy-seven and one-half feet white sand rock............... | 77½ |
| Whole depth.................. | 252 |

An abundant supply of water was obtained at the depth of 150 feet. This supply, however, was not tested until after the well had been bored one hundred feet below it. The drill at that point, became fixed and immovable, so that the contractor was wholly unable to proceed further when, after experimenting with pumps, it was found that the supply was sufficient for all practical purposes.

The water was obtained after drilling about ten feet in the lime rock of No. 32.

From this source the water rose in the well about eighty feet. The water is supposed to be of excellent quality.

Of these, No. 34 is plainly the St. Peter sandstone. No. 33 is the green shale which is nearly always seen over the sandstone in Hennepin and Ramsey counties. Nos. 32 to 29, inclusive, include the Lower Trenton, but the thickness seems greater than elsewhere observed, being 36½ feet. The rest of the drill seems to be taken up with alternating shale and limestone layers, the greater portion being of shale. Of this thickness (101½ feet) probably the main mass of shale, near the bottom, said to have been 28½ feet thick, represents the green shales that had before been identified; but there is not sufficient difference between this and the rest to exclude the application of the same term to the whole of the beds above No. 29.

A few months later an exposure of green shale was seen in the road, N.W. ¼ Sec. 9, in Reserve, accompanied by *Chœteets* and *Orthis*, above the level at which the regular green shale could exist. Blocks of fossiliferous blue limestone were also seen abundantly along a ravine in the same township, (Sec. 15) mixed with the debris of the red hardpan clay, far above the level of the Lower Trenton; a circumstance at variance with any thing before seen in Ramsey county. Finally, the beds in place were found in a good exposure along Ramsey street in St. Paul, where it ascends St. Anthony Hill. They were first seen in a little artificial ravine made for a watering tank. They are exposed in a similar manner in other ravines that descend St. Anthony Hill toward the river, farther west. The basis rock of St. Anthony Hill is the same. Their thickness above the Lower Trenton is 108 feet, and they have a conspicuous strike, as already stated, in a line of drift-covered bluffs that run from St. Paul northwestwardly, reaching Anoka county south of Rice creek, causing the high and hilly land there seen. These beds also form the nucleus of the high land that extends from St. Anthony Hill southwestwardly toward Fort Snelling, distant about three-fourths of a mile from the river.

These beds are very shaly, not more than one-third of the whole being limerock, and contain the usual fossils of the Lower Trenton, but their paleontology has not yet been examined carefully. The whole formation seems to have the characters of the Cincinnati, as exposed in Green Bay, Wisconsin, or in Ohio.

### *The Trenton Group.*

In New York the Trenton limestone is succeeded by a mass of shales with the local designations, Utica slate, Frankfort slate, Shales and sandstones of Pulaski, and Lorraine shales. These were all em-

braced in the term Hudson River Group, which had before been applied to a mass of shales that are now known to be much lower. On account of this error the term Cincinnati Group has been generally substituted.

On the other hand in Iowa and southern Wisconsin and Minnesota, the Trenton limestone is found to pass into the Galena by slow stages and to be followed, at least in Iowa, by a greatly reduced representative of the Cincinnati Group, named by Dr. White the Maquoketa shales. Leaving Iowa and passing into Minnesota the Trenton limestone increases in thickness, and the Galena diminishes, the latter becoming interstratified with beds of shale. In Olmsted county, still further north, the Trenton also contains numerous beds of shale and the Galena is still further reduced. The beds are traceable by continuous or frequent outcrops throughout Goodhue and Rice counties, with an increasing amount of contained shale in the Trenton, and finally with the total loss of the Galena. On account of the soft and shaly nature of the upper beds, by the time they reach Ramsey county they are so covered with the greater drift accumulations that their presence so far north had not before been suspected. Here is an ascertained horizontal change in the character of the beds of this formation, between the southern and central portions of Minnesota, which brings up the question as to the designation they should bear at St. Paul. They are the horizontal equivalents of what has been recognized as the Trenton formation in the southern part of the State, and in neighboring States, and contain the same fossils; but they have the lithological character and the geological position of another well organized group of rocks in Ohio and northern Wisconsin. The eastern Cincinnati fossils are also the western Trenton fossils. Here we have two equally well established names for the same series of beds.

The cause of this gradual change in the formation from dolomitic limestone to a pure limestone, and then to an argillaceous limestone, and at last to a mass of calcareous shales, is to be sought for in the character of the ocean's bed, and the nature of the water and its currents, in the Silurian ocean. And here it is only necessary to apply a well known law of ocean sedimentation. viz.: *the nearer the shore the shallower the water, and the coarser the sediment.* This seems to make dolomitic limestones in the deepest waters, ordinary limestone in deep water, and shales and sandstones in shoal water. The strike of the formation under consideration passes through all these conditions and directly toward the metamorphic area of the State which lies but little further north. Hence, at St. Paul the water was much shallower than at Rochester, and the sedimentation was much coarser; while at Rochester there was much more shaly sediment than at Dubuque. The direction of the strike of these rocks in New York State is along the shore-line of the ancient ocean, and hence the opportunity for noting this change was much less favorable. In Wisconsin and Minnesota the strike is north and south, and in Minnesota rapidly approaches the ancient shoreline.

*The Drift.*

While the county is wholly covered with a red hardpan clay, believed to be of the age of the first glacial epoch, it shows some variations that require special mention, and is also furnished with a lake deposit which forms the surface soil.

At St. Paul the red hardpan is found uniformly in excavating for buildings in all that low area about the levee, and in the deep cuts through the gravelly bluff north of E. Third street. Although here it is covered with sometimes more than forty feet of lighter-colored drift materials, it emerges from under these immediately on getting outside the valley either north or south, and is covered, but sometimes thinly, with the loess loam. This overlying loose drift is found along the Mississippi valley throughout the county, and everywhere shows the action of water in its deposit. It very seldom contains any clay, and when it does the clay is stony and has a different color from the red hardpan clay. Above Fort Snelling, and in the western part of Reserve and Rose tôwnships, the red hardpan has not the same clayey and unmodified character that it has in the eastern part of the county. It seems to have been washed by water, and in that manner to have lost some of its clay, while there are localities where materials of a different color, particularly gravelly deposits, are superimposed or mixed with it, so that sections seen along the western part of University Avenue have a confused arrangement and mingling of the coarse water-worn materials of both the red hardpan and the gray, with occasional patches of gray hardpan. This water-washed condition also prevails in the low gravelly knolls and ridges that are seen occasionally in the northern flat part of the county, but without any intermixture of materials referable to the gray hardpan. In the high and rolling tract occupied by the Upper Trenton, this red hardpan shows to the best advantage, whether in the western or eastern part of the county. In the deep excavations made in St. Paul this red hardpan is seen to be overlain by a fine red laminated clay, which is probably of the same nature and origin as the so-called *Tripoli* found at Stillwater, the thickness of which sometimes reaches six or eight feet, but which in some places is entirely wanting. This seems to be related to the underlying hardpan sheet somewhat as the laminated brick clays and loams of later date are to the gray hardpan which they overlie, and was deposited during the waning period of the former glacial epoch, and when water was abundant but comparatively quiet.

What has now been described, *i. e.* the red hardpan and the red laminated clay overlying it, were the products of a glacial epoch which brought its materials from the north and northeast, the red color being due to the prevalence of the debris of red sandstone, shale, and other iron-charged rocks that are developed largely in the vicinity of Lake Superior. Whether this ice-period preceded or followed the excavation of the immense gorge of the Mississippi which is visible southward from Dayton's Bluff in St. Paul, is not ascertained by any observed facts, but several considerations would require a date subsequent to that excavation—or to the greater portion of it. It is probable the Mississippi began to excavate that gorge at the time of the elevation that brought the upper Trenton (or the Cincinnati) above the Silurian ocean, an event which has been taken to divide the Silurian in America into two parts, the upper and the lower. In that case it is the oldest portion of the Mississippi gorge at present known, and has since that event carried off the waters of the Metamorphic land areas of Wisconsin and Minnesota. The St. Croix valley seems to be equally old, and perhaps served for the drainage mainly of the Wisconsin area, while this carried only the waters of the Minnesota area, the two uniting then, as now, at or near Hastings. The sculpturing of the rocks into canyons in the western portion of Wisconsin, and their uniform trend southwestwardly show they must always have reached either the ocean or a great river, lying in that direction. Isolated areas of the Trenton in northwestern Wisconsin, as well as in central Minnesota, left to the present without destruction, though surrounded by larger areas of older formations deeply cut by the same forces into gorges and wide valleys, point directly to the close of the Lower Silurian as the starting point of the history of this part of the Mississippi valley. The rest of the valley-gorge, even to the Gulf of Mexico, being composed of much later formations, must have been unformed, even buried in the slowly accumulating sediments of the ocean for many ages later. If some portions of it are wider, or deeper, than this, it is due to greater volume of water, and to softer rocks, not to greater age. It is probable, then, that the advent of the first glacial period did not divert the Mississippi river from its channel below St. Paul. But the valley is much narrower above St. Paul than it is below, and this continues indefinitely southwestwardly by way of the Minnesota valley. This is very noticeable on examining the geological map accompanying this report. There is also a significant change in the direction, and one the more significant as it seems not to have been due to any rock formation existing at St. Paul, but directly

contrary to the rock sculpturing that exists there favorable to the continuance of the river in any preoccupied valley running in the same direction. Allusion has been made to a possible ancient gorge through the Trenton north of St. Paul in describing the surface features of the county, but in the geological map of the county no such gorge is represented, because it never has actually been discovered, and its hypothetical location would perhaps be of no service.

These anomalous and significant facts can all be reasonably explained on the supposition that the Mississippi river was diverted from its ancient valley-gorge, north of St. Paul by the ice and drift of the first glacial epoch, and that it was driven into that which has been described in the report on Hennepin county, toward the west further, and joined the Minnesota valley at some point above Fort Snelling, but between that point and Shakopee, without passing over or through the Trenton limestone at all. Their united waters then formed the river which excavated the gorge between Fort Snelling and St. Paul (unless the Minnesota alone had already done it) between the first and second glacial epochs.

When the second glacial epoch came on, the country must have been more or less covered with constant or periodical ice sheets for many miles south of the line limiting actual glacier movement. These minor local and seasonal ice-areas produced their subordinate effects, but so similar to those of the great moving glacier itself that it is rendered very difficult, except with the aid of certain marked differences in the nature of the transported material, or some fortunate topographical or other evidence, to define the area of the second great glacier as compared with that of the first. These local ice-areas, which could not have had much movement as ice, served to disturb the surface of the old drift, and, by the water they afforded on breaking up periodically, to carry away the clayey parts, and to mix superficially the materials of the new drift with the old. At points, like that of Hennepin and Ramsey counties, where a great river course co-operates to mix these materials, we would necessarily see the new extending farthest over the old, and even the effects of ice in large masses extending down the valleys further than on the uplands.

In Hennepin county, and generally over the northwestern part of the State, are evidences that the ice of the second glacial epoch moved rather from the northwest than from the northeast. (See Hennepin county report, 1876.) The washed surface of the old drift, and the area of the loess-loam, both indicate that Ramsey county and the southeastern part of Hennepin were not disturbed

generally by the glacial ice of this epoch. The disturbance, however, was sufficient to choke up again the Mississippi river, and at the mouth of Bassett's creek in Minneapolis, to drive it to the east, as fully detailed in the report on Hennepin county, thus bringing it into the channel that it now occupies between Bassett's creek and Fort Snelling.

The drift of the second glacial epoch is found as a stony clay in few places in Ramsey county. In some of the excavations at St. Paul, in the lower portions of the city, a gray hardpan is found, and there may be a considerable of it even under the water of the river itself, filling a deep gorge, but it lies over the red hardpan when that also is present. The disintegration and wash from the shales of the Upper Trenton seems also to have mixed with the drift at St. Paul so abundantly as to produce a stony gray clay which is hardly distinguishable from the true glacial clay. Some parts of Reserve township also show patches of the gray hardpan, rather mixed with than overlying the red.

As a gravel or course sand, the product of the second glacial epoch is much more abundant in Ramsey county. The gray gravel and sand, with the washed limestone pieces and boulders composing the bluffs and hills that have been so much excavated for streets at St. Paul, are the modified product of the second glacial epoch, modified at the time of their origin and deposition by the water resulting from the disintegrating margin of the glacier (perhaps here feebly extended to this point) but augmented by the co-operation of the natural waters of the Mississippi, then swollen to great dimensions. The same deposit, but much less abundant, produced by the same agency (except the presence of the Mississippi) is spread over much of Reserve or Rose townships, and has already been alluded to as the indirect effect of the second glacial epoch over the pre-existing drift surfaces.

Occasional pieces of northern limestone are found in the drift ridges and knolls about Mudhole and Fitzhugh and Gervais lakes, and two pieces of native copper were found on the south side of White Bear lake, near the Ramsey county line. Indistinct glacial marks in West St. Paul, under the red hardpan, run W. N. W.; but this was an unsatisfactory observation.

### *The Loess Loam.*

That this deposit is the result of widespread diffusion of fresh water, at the time of the last glacial epoch, over those surfaces either drift-covered or not, which were not at the time affected by

the glacier movement, is highly probable: but what the peculiar circumstances and causes of such gentle diffusion of nearly tranquil waters were, it is not yet possible satisfactorily to detail. The loess loam is found in all parts of Ramsey county, but it varies in thickness and in composition. It is thin or wholly wanting in some rolling gravelly tracts, and is very thick in some confined valleys. It is sandy, or graduates downward into sand, in much of the northern part of the county, particularly in Rice Creek valley, and in some places in the bluffs of the Mississippi below St. Paul, and it is fine and somewhat clayey in the high and rolling clay tract in the eastern part of the county, particularly in the eastern part of New Canada. It forms a very fine soil for farm crops. It covers the boulders and gravelly clay of the real drift. It fills some old valleys —indeed is always thicker in valleys than on the uplands. It is occasionally stratified and passes into sand below in places where agitated water was abundant enough to have moved such materials before the epoch of the loam. In other cases it is placed abruptly immediately over a coarse, gravelly or boulder-bearing stratum.

In the southwestern corner of the state (Rock and Pipestone counties) there is a gradual change from stony boulder-clay to the loess loam, horizontally, in passing from the Coteau de Prairie (in Lyon and Murray counties) southward to the Iowa state line. Exposures along the banks of creeks, and the digging of wells, make this plain. There is a gradual loss of boulders, then of the small stones, then of gravel: and an equally gradual increase of the characteristic features of the loess-loam,—close, clayey consistency, crumbling in the air like slacking quicklime, and white limy concretions. In some cases the concretions, which have been so often mentioned as a peculiarity of the loess-loam, are in the same deposit with small gravel stones of northern origin; and pieces of northern limestone. The drift clay, true northern boulder clay, the product of glaciers, thus changes gradually into a true loess-loam, the product of aqueous agencies. While this indicates for that locality, at least, a merging of one force into the other, and the slowness of the change, through an interval of about 50 miles in a broad, level, open country, it perhaps gives the key to the events that occurred in other latitudes where the surface was more broken, and where the effects are more complicated by not having all the steps recorded. Just as in the older geological formations, wherever the series is complete, without sudden transitions, the history is best known, so in the history of the drift, where the effects change gradually, are the records of "lost" epochs, and these "beds of transition" need the closest scrutiny, being the only evidence of what transpired

between formations which in other regions pass abruptly from one to the other. This here indicates that the age of the loess-loam was cotemporary with that of the boulder clay in the Coteau de Prairie. There must be some explanation given for the co-existence of these forces which spread the loam and those which brought the glacial drift. In other words, if the loam, which is sometimes a laminated clay, be regarded as the equivalent in age of the fine laminated clays of the great lakes and of other high-water marks in the northwest, which have been referred to a distinct "epoch" by Dana and others (the Champlain), then that epoch was not subsequent in time to the glacial epoch but cotemporary with it, and its phenomena differ from those of the last glacial epoch because they have been studied at distant points where they are contrasted, and where the glacial winter operated differently. Where there is an immediate succession of superposition, that fact in the drift does not imply immediate succession in time any more than it does in the Silurian rocks, a fact which has been ignored many times; and hence have resulted a great many special histories and theories. The loess-loam, for instance, lies on the older drift clay all along the Mississippi valley, and has generally been taken to prove an immediate transition from the drift-epoch to the loam-epoch, when really a long period of time, involving forest growths and the slow on-coming of a glacial epoch, intervened, the loam itself passing horizontally into the glacial deposits of that epoch.

So in Ramsey county the loam has been seen to follow by insensible gradations from a sand or even a fine gravel, the change here taking place perpendicularly. In this case the coarser deposit below was the result of more copious and more agitated water, as in the bluff-terraces below St. Paul, or in the washed materials in the western part of Reserve township, and the loam the result of the diminution and more quiet state of the same waters. Thus, if the waters which overspread and washed the old drift and formed the gravelly terraces of the Mississippi came from the ice-fields of a contemporary glacier lying further north. then the waters which spread the loam, a finer deposit, also came from the same source, operating a little later, and with diminished force.

### *Wells in Ramsey County.*

Good water for all household purposes is obtained in Ramsey county with little effort, in shallow wells that seldom pass through the drift, the majority of them being less than twenty-five feet deep. Throughout the northern portion of the county water is generally

found in sand, or below a sandy loam, which also rises to the surface forming the soil and subsoil. The underlying clay is seldom penetrated to any great depth. But in the southern portion wells more frequently are deeper, and obtain water in gravel after passing through not only the surface loam but also a greater or less amount of red clay.

### *Material Resources—Timber.*

The county is generally clothed with a scant forest growth, but the trees are small. There is not much timber of any sort suitable for lumber. and it is not much cut for fuel. Farmers cut some and haul it to St. Paul, but the wood fuel of St. Paul is very largely supplied from the "Big Woods," west of the Mississippi river.

The county has generally a good soil, the most of which still lies in its primeval condition. So far as the natural resources of the county are concerned, they lie in its soil to a greater extent than in any thing else.

### *Building Stone.*

The stratum of the Lower Trenton used at St. Paul is the same as at Minneapolis, and furnishes a stone similar in all respects. The stone for the piers of the bridge over the Mississippi was taken out in West St. Paul, but about half a mile above the bridge.

The quarries in West St. Paul are in the public street, and are worked by Adam Rowe.

On the other side of the river, Mr. Sigler has quarries in operation on Stewart Avenue, near Leech street. The most important quarries in St. Paul are near the State Capitol, but there are a great many other small openings in different parts of the city.

Although this formation has been used in the majority of the stone buildings in St. Paul, and makes a fine appearance, yet its tendency to disintegrate has caused it to be less regarded, and has led to the introduction of other building stone. The U. S. Custom House is built of Sauk Rapids granite, and the Baptist Church of the Shakopee limestone quarried at Kasota.

Along the south side of White Bear lake, Sec. 32, Grant, Washington county, are exposures of the Trenton, some of which have been opened by Messrs. Walter and Weaver. Another is on the land of Mr. Huffman on Sec. 30, nearer the lake, in the bluffs facing northeast; and still others are further south and east. There is every reason for expecting as good building stone here as at St. Paul, except that the beds would naturally be a little more shaly,

being situated nearer the ancient shore line when the deposit was forming, and for the same reason that makes the Trenton at St. Paul more shaly than at Faribault. These exposures, however, have not been much worked, and do not seem to be generally known.

### *Mills and Water-Powers.*

The *St. Paul Mills*, St. Paul, are owned by Henry Shaber, and are on Phalen's creek. They have three run of stone for flour and one for feed. Have 20 feet fall of water, and turbine wheel. Only grind for custom use.

The *Brainerd Mills*, (Thau and Ham), have three runs for flour and one for feed, and are also in Phalen's creek, with 30 feet fall and turbine; custom and shipping.

The *City Mills*, (Lownsman, owner) St. Paul, have two runs of stone for flour, and 19 feet fall; custom only.

The *North Star Mills* are also at St. Paul, and have three runs of stone for custom work, and 19 feet fall, owned by Protz and Braun.

The *Union Mills* are owned by W. Lindeke, with four run of stone, and 20 feet fall, situated at St. Paul.

The last three above are run by overshot water-wheels.

The *Reserve Mill* are on the Fort Snelling road, at St. Paul, and are only calculated for grinding feed; have two runs of stone and 20 or 21 feet fall; owned by — Cunrad. These mills used to do flouring.

### *Brick in Ramsey County.*

John Jæger, St. Paul, on Dayton's bluff, makes red brick from the loess loam.

Graham & Co., W. St. Paul, make red brick from clay taken from the alluvium of the flood plain. This yard, however, is now inactive, and is owned by John Jæger.

Section 32, White Bear. Formerly a good red brick was manufactured at a point between the railroad and the lake shore (Vadnais lake), from the surface loam that here covers the country, but as the owners were not much patronized, owing to the general financial depression which retarded all building, the yard was closed, and remains so.

The brick clay which is seen in the bluffs at St. Paul, in the excavations made for street purposes on Fifth street, between Sibley and Wacouta, lies between deposits of coarse gravel and stones, all water-washed. This clay, which is probably the near equivalent in age and nature of the brick clay so extensively used for brick at Minneapolis and Carver, has not been thus employed at St. Paul.

*Earthworks.*

On Dayton's Bluff are several large mounds, one being about six feet high and 30 or 40 feet across.

At White Bear Lake is a large artificial mound, about 12 feet high and 35 or 40 feet across. It is close to the shore of the lake, within the village, on lot 2, on the road to Goose Lake.

In Dayton's bluff, on P. Kelly's place, is a covered cave in the white sandstone, not far from Carver's cave, in which is a deposit of clay containing lumps, and some large pieces, of what goes by the local name of "kaolin." It is purely white, tasteless, and gritless, and seems to be the same as the white veinings found in the lacustrine clay of the Red river valley. This clay is said to completely fill the cave, which was discovered in digging to make room for a house and barn in the lower part of the bluff. The clay resembles that seen at Mankato in the nooks of the Shakopee rocks, as described in the Second Annual Report, but it has not been possible to give it, nor the cave, any satisfactory examination. It is probably of the nature of Carver's cave itself; and they should both be carefully examined for traces of ancient habitation.

In another part of the Annual Report for 1877 will be found further account of early man in Ramsey county, and illustrations of some implements found in St. Paul.

The survey of Ramsey county was facilitated by the active interest and guidance of Hon. C. S. Bryant, of St. Paul.

# VI.

# THE GEOLOGY OF ROCK AND PIPESTONE COUNTIES.

## *Situation and Area.*

These counties form a rectangle running north and south, in the very southwestern corner of the State, and border on Iowa and Dakota. They have a width of a little more than three government towns, and each a length of four.

*Surveying Statistics of Rock County.*

BY F. E. SNOW.

| Township. | Range. | TOWNSHIP LINES. | | SUBDIVISIONS. | Acres. |
|---|---|---|---|---|---|
| | | | When Surveyed. | When Surveyed. | |
| 101 | 44 | S | August ... 1852 | September .. 1869 | 23,035.46 |
| ... | .. | N. E. W | July, August ... 1867 | | |
| 102 | 44 | N. E. S. W | July, August ... 1867 | September .. 1869 | 22,929.55 |
| 103 | 44 | N. E. S. W | July, August ... 1867 | September .. 1869 | 23,078.93 |
| 104 | 44 | N | September ... 1858 | October ... 1869 | 23,081.10 |
| ... | .. | S. E. W | July, August ... 1867 | | |
| 101 | 45 | S | July ... 1852 | November ... 1869 | 22,948.32 |
| ... | .. | W | September ... 1858 | | |
| ... | .. | N. E | July, August ... 1867 | | |
| 102 | 45 | W | September ... 1858 | November ... 1869 | 22,941.68 |
| ... | .. | N. E. S | July, August ... 1867 | | |
| 103 | 45 | W | September ... 1858 | October ... 1870 | 22,997.45 |
| ... | .. | N. E. S | July, August ... 1867 | | |
| 104 | 45 | W. N | September ... 1858 | October ... 1870 | 22,974.94 |
| ... | .. | E. S | July, August ... 1867 | | |
| 101 | 46 | S | July ... 1852 | September ... 1870 | 23,048.40 |
| ... | .. | E | September ... 1858 | | |
| ... | .. | N. W | September ... 1867 | | |
| 102 | 46 | E | September ... 1858 | September .. 1870 | 23,072.24 |
| ... | .. | N. W. S | September ... 1867 | | |
| 103 | 46 | E | September ... 1858 | Sept., Oct ... 1870 | 23,038.05 |
| ... | .. | N. W. S | September ... 1867 | | |
| 104 | 46 | E | September ... 1858 | July ... 1871 | 23,100.92 |
| ... | .. | N | September ... 1861 | | |
| ... | .. | S. W | September ... 1867 | | |
| 101 | 47 | S | July ... 1852 | September ... 1870 | 7,928.52 |
| ... | .. | W | July ... 1859 | | |
| ... | .. | N. E | September ... 1867 | | |
| 102 | 47 | W | July ... 1859 | September ... 1870 | 7,889.56 |
| ... | .. | N. E. S | September ... 1867 | | |
| 103 | 47 | W | July ... 1859 | September ... 1870 | 7,862.81 |
| ... | .. | N. E. S | September ... 1867 | | |
| 104 | 47 | W | July ... 1859 | July ... 1871 | 7,788,18 |
| ... | .. | N | September ... 1861 | | |
| ... | .. | E. S | September ... 1867 | | |
| | | | Total | number of acres | 307,716.11 |

## *Surveying Statistics of Pipestone County.*

BY F. E. SNOW.

| Township. | Range. | TOWNSHIP LINES. | | SUBDIVISION. | Acres. |
|---|---|---|---|---|---|
| | | When Surveyed. | | When Surveyed. | |
| 105 | 44 | S. | September 1858 | August 1867 | 23,006.06 |
| | | N. E. W. | July, August 1861 | | |
| 106 | 44 | N. E. S. W. | July, August 1861 | August 1867 | 23,064.09 |
| 107 | 44 | N. E. S. W. | July, August 1861 | Aug., Sept. 1867 | 22,998.97 |
| 108 | 44 | N. | September 1858 | September 1867 | 22,885.66 |
| | | E. S. W. | July, August 1861 | | |
| 105 | 45 | S. W. | September 1858 | September 1867 | 23,434.99 |
| | | N. E. | July, August 1861 | | |
| 106 | 45 | W. | September 1858 | September 1870 | 23,451.93 |
| | | N. E. S. | July, August 1861 | | |
| 107 | 45 | W. | September 1858 | September 1870 | 23,527.78 |
| | | N. E. S. | July, August 1861 | | |
| 108 | 45 | N. W. | September 1858 | July 1871 | 23.468.29 |
| | | E. S. | July, August 1861 | | |
| 105 | 46 | E. | September 1858 | July 1871 | 23,048.16 |
| | | S. | September 1861 | | |
| | | N. | September 1870 | | |
| | | W. | July 1871 | | |
| 106 | 46 | E. | September 1858 | Sept., Oct. 1870 | 23,001.83 |
| | | N. W. S. | September 1870 | | |
| 107 | 46 | E. | September 1858 | October 1870 | 23,044.78 |
| | | N. W. S. | September 1870 | | |
| 108 | 46 | E. | September 1858 | July 1871 | 22.959.70 |
| | | N. | September 1861 | | |
| | | S. | September 1870 | | |
| | | W. | July 1871 | | |
| 105 | 47 | W. | July 1859 | July 1871 | 4,852.06 |
| | | S. | September 1861 | | |
| | | N. | September 1870 | | |
| | | E. | July 1871 | | |
| 106 | 47 | W. | July 1859 | October 1870 | 4,783.90 |
| | | N. E. S. | September 1870 | | |
| 107 | 47 | W. | July 1859 | October 1870 | 4,771.48 |
| | | N. E. S. | September 1870 | | |
| 108 | 47 | W. | July 1859 | July 1871 | 4.588.07 |
| | | N. | September 1861 | | |
| | | S. | September 1870 | | |
| | | E. | July 1871 | | |
| | | | Total | number of acres | 296,887.75 |

*Natural Drainage.*

The drainage is toward the south and southwest, and finally enters the Missouri river near Sioux City, in Iowa, being the only water from the State of Minnesota that takes that route to the Gulf of Mexico. The main stream is Rock river, which flows almost due south, receiving several tributaries from the east, but none that are important from the west. Other streams rise west of Rock river, having their headwaters near that stream, but flow westward, leaving the State, and finally reaching Big Sioux river. These latter are the Flandrau, Pipestone, Splitrock and Beaver creeks.

These streams are all small, and in the summer time some are rather valleys where gathers a little water, than living streams. They furnish no water-powers that have been improved, as yet, though without doubt, some parts of Rock river would furnish sufficient fall for milling by a little artificial aid.

*Surface Features.*

These are emphatically prairie counties, and are nearly level over large tracts. They are undulating in their eastern portions, due to the existence of more numerous streams whose valleys lie rather deeply below the general level. Along the valley of Rock river and its tributaries is the greatest diversity seen in these counties, and this is mainly confined to Rock county, though the high peninsula between Rock river and Chanaranbie creek in the southeastern part of Pipestone is a prominent object in the horizon for many miles.

Rock river valley is about a mile or a mile and a half wide. The immediate banks are from six to ten feet above the water, and are composed of gravel, which is sometimes coarse, and is very largely made up of limestone. The outer banks are from fifty to seventy-five feet higher, and on the eastern side are more stony with foreign boulders than on the west, a circumstance, however, which may be owing to the action of the prevailing western winds, which would uncover and keep bare the coarser materials of the surface by blowing away the sand and clay during the dry and windy months of the year, while the bluffs on the west side would not only not receive such winds, but would serve to collect all particles flying toward the east from the prairie above.

The range of high rocky land running northwest from Mound, near Lu Verne, is a conspicuous object in the horizon from the north and east, and looks like the Coteau from Marshall. The highest point is where it breaks off squarely to the valley of Rock river, and

As this locality has become somewhat famous on account of the extensive use made of the red pipestone by the Indians, and the difference of opinion expressed by scientists as to its origin and age, the following *resume* will be of interest:

The first written account of the quarry was by George Catlin, found in the 38th volume of the First Series of the American Journal of Science and Arts, p. 138, in a letter addressed to Dr. C. T. Jackson, to whom he also sent a sample of the pipestone for analysis. The journey was made on horseback from the falls of St. Anthony, in the summer of 1836, in company with "a young gentleman from England, of fine taste and education," and a single Indian guide. Mr. Catlin describes the quarry as "on the very top" of the Coteau des Prairies which rises above the country about it with graceful and almost imperceptible swells. The quartzyte he regards "a secondary or sedimentary deposit," but no further defines its supposed age.

Jean N. Nicollet visited the quarry in July 1838, as is plainly shown bv his own name and date for that year, together with the initials of his companions, boldly and artistically cut on the quartzyte, at the top of the ledge, near the "Leaping Rock," and a little north of where the creek passes over the brow of the escarpment. His "Report, intended to illustrate a Map of the Hydrographical Basin of the Upper Mississippi river," is "Document 237," of the second session of the 26th Congress, ordered printed Feb,, 1841. He gives no opinion of the age of the rock, but quotes Dr. Jackson's analysis of the pipestone, or *Catlinite*, as it was named by Jackson. "As a mineralogical species it may be described as follows: compact; structure slaty; receiving a dull polish; having a red streak; color blood red, with dots of a fainter shade of the same color; fracture rough; sectile; feel somewhat greasy; hardness not yielding to the nail; not scratched by selenite, but easily by calcreous spar; specific gravity 2.90. The acids have no action upon it; before the blowpipe it is infusible *per se*, but with borax gives a green glass," While Prof. Jackson assimilates it to *agalmatolite* (*pinite* of Dana) Nicollet regarded it as differing very materially from it in general aspect, its conduct before the blowpipe, and its total insolubility in sulphuric acid.

Prof. James Hall, next in chronological order, read a paper before the *American Philosophical Society* in June, 1866, in which, among notes on the geology of some of the western portions of Minnesota, he classes the red quartzite as Huronian. He imagines the Coteau des Prairies caused by a vast synclinal in the rocks of this age. He did not see the pipestone quarry itself, having only gone to Lake

Shetek, where he describes a wall of rock which he thinks the same in age. His examinations were made in 1865. His is the first attempt to fix the age of this rock.

Dr. F. V. Hayden visited and examined the locality in October, 1866, and his account is in the *American Journal of Science and Arts* for January, 1867. After examining rock of the same kind on the James and Vermilion rivers, in Dakota, and at Sioux Falls, on the Big Sioux river, he gives an interesting detailed description of the quarry, and inclines to the opinion that the quartzyte is supra-carboniferous, Triassic perhaps, or an extension downward of Cretaceous No. 1.

Dr. C. A. White has given a description of a "Trip to the Great Red Pipestone Quarry," in the *American Naturalist* for 1868–9, but he does not there state anything concerning the age of these rocks, though elsewhere, he has ranked them as pre-Silurian, and named the formation the "Sioux Quartzyte." (Geology of Iowa, 1870).

The reader is further referred to the first and second Annual Reports for reasons for believing this formation to be the equivalent of the Potsdam sandstone of New York.

The known area of this rock in Rock and Pipestone counties is approximately marked out on the accompanying map, but there is much probability of its being much greater, and perhaps to include the greater portion of both counties. The Cretaceous formation, no doubt, also occurs in the northern part of Pipestone county, and overlies unconformably the quartzyte in other places, but it has not been seen. Dr. Hayden has mentioned such facts in his account of the geology of southwestern Dakota, occurring at or near the mouth of Firesteel creek, on the James river.

At the Red Pipestone quarry there is a ledge of rock which runs north and south nearly three miles. This ledge of rock consists of layers of red quartzyte that have a dip of fifteen or twenty degrees toward the east, so that the rock soon disappears under the prairie in that direction, but presents a nearly perpendicular escarpment toward the west, formed by the broken off heavy layers of the rock; though its greatest hight, which is not more than 25 feet, is a little north of the present pipestone quarry. It also gradually disappears under the prairie both toward the north and toward the south, the lower ground on the west of the escarpment slowly rising, in those directions like the sides of a basin, and coalescing with that on the east of the ledge. A small stream, dry some parts of the year, known as Pipestone creek works northwestwardly and passes over the ledge from the upper prairie to the lower with a perpendicular fall of about 18 feet. In the vicinity of this fall, and also at one or

two places further south, are dwarfed bur-oaks and shrubs, but the country in all directions for many miles is a prairie which has a great monotony of surface. It is not on the top of the Coteau de Prairie, as supposed by Catlin, that range of hills being 25 or 30 miles further northeast. Mr. Catlin seems to have correctly described the eastern ascent of the Coteau as rising with almost imperceptible swells above the prairies further east, but failed to observe when he passed down the western slopes, that the real Coteau dies out still more insensibly into the prairies on the western side. The Coteau passes nearly through the middle of Lyon county, the northeastern quarter of Murray, the southwestern part of Cottonwood, and leaves the state along the western side of the DesMoines river, in Jackson county, gradually becoming less noticeable. It is characterized by numerous lakes and gravelly drift hills. It is a vast glacial moraine, comparable to the ridges in northwestern Ohio, and the "Kettle Range" in Wisconsin, but is the most remarkable, as it is the most extended, glacial moraine known in the United States if not in the entire world. It runs along the east and north side of the Missouri river till it passes out of the United States into British America.

The little stream which crosses the rock at the pipestone quarry widens out into a lake just before passing the ledge, making Pipestone lake, and again after passing it, it forms Crooked, Duck and Whitehead lakes in the same way. In these lakes water stands constantly.

The rock itself in general is exceedingly hard, in heavy layers of one foot, or of two or three feet, and is separated by jointage planes into huge blocks of angular shapes that lie often somewhat displaced or even thrown over entirely by the action of the frost through many winters. Thus, there is a rough talus along the foot of the escarpment where grow a few bushes and small oaks, protected from the prairie fires by surrounding masses of fallen quartzyte. The rock is sometimes pinkish and massive; when blood-red it is more apt to be thin-bedded.

The real "pipestone quarry" is situated about a quarter of a mile west of this ledge and in the low land of the lower prairie. Earlier diggings seem to have been opened in the superficial outcroping of the pipestone layer, and to have followed along its strike north and south nearly a mile, without penetrating very deeply into the rock. The layer which furnishes the pipestone is about 18 inches thick, and is embraced between heavy layers of the same rock as the ledge already described, and they all dip together toward the east, and of course run under the main escarpment. The present quarrying is

a little east of the line of old diggings, but follows along the strike of the formation the same as the other, the only difference being in having greater depth (the pipestone layer is about 6 feet under the ground here) and in the difficulties encountered in removing about five feet of very firm, pinkish quartzyte in heavy beds.

The Catlinite itself is a fine clay varying in color from blood-red to pale red, or pinkish, or even to a pale yellowish red. The lighter colors fade into the darker, but sometimes the light appears in the red as round spots, on a polished surface, but the red is not thus distributed through the lighter shades. It has, of course, suffered all the metamorphic influences that the quartzyte itself has, but it has not lost its distinctly bedded structure, which may be seen when examined microscopically in polished thin sections. Indeed it seems to have a laminated structure; and the different shades of color appear sometimes to be due to openings and fissures produced in the red clay and becoming filled with sediment of a lighter color. It seems to be made up of little grains of quartz having an abundant cement of red ferric oxide, the alumina present (as indicated by chemical analyses) being mixed rather with the latter than combined with the former.

Prof. Peckham, who has analyzed for the survey samples of the red and of the pale red pipestone, makes the following report:

*Prof. N. H. Winchell:*

MY DEAR SIR—I have the pleasure to report the following analyses of serial numbers 52 and 53:

*No. 52—Pale Catlinite.*

| | | | |
|---|---|---|---|
| Silicic oxide | $Si O_2$ | 58.25 | per cent. |
| Aluminum oxide | $Al_2 O_3$ | 35.90 | " |
| Water | $H_2 O$ | 6.48 | " |
| Total | | 100.63 | |

The aluminum oxide is a trifle too high and contained a trace of iron ($Fe_2O_3$.) This specimen did not contain an appreciable amount of either lime or magnesia.

*No. 53—Red Catlinite.*

| | | | |
|---|---|---|---|
| Silicic oxide | $Si O_2$ | 57.43 | per cent. |
| Aluminum oxide | $Al_2 O_3$ | 25.94 | " |
| Ferric oxide | $Fe_2 O_3$ | 8.70 | " |
| Water | $H_2 O$ | 7.44 | " |
| Total | | 99.51 | |

This specimen contained in addition a trace of both lime and magnesia.

A comparison of these results with those given in Dana's Mineralogy, ed. 1870, confirms the statement there made that Catlinite is a rock and not a mineral. The substance appears to be an indurated or partially metamorphosed clay containing a variable amount of ferric oxide and water.

An analysis by the late Dr. Jackson, of Boston, (Am. Jour. Sci., I. xxxv., 388) gives the following in 100 grains:

| | |
|---|---|
| Water | 8.40 |
| Silica | 48.20 |
| Alumina | 28.20 |
| Magnesia | 6.00 |
| Per-ox. iron | 5.00 |
| Ox. Manganese | .60 |
| Carb. lime | 2.60 |
| Loss (probably magnesia) | 1.00 |
| Total | 100.00 |

These results indicate a considerable amount of earthy carbonates and when compared with those given above show that the rock is quite variable in composition. Neither of the specimens analyzed by myself was of the spotted or mottled variety, which *may* account for the presence of the earthy carbonates in the analysis by Dr. Jackson.

The red variety was found to be much more difficult to decompose by fusion with alkaline carbonates than the average silicates. It was found necessary not only to reduce it to an impalpable powder but to prolong the fusion to from eight to ten hours to insure complete decomposition.

Respectfully submitted,

S. F. PECKHAM,

MINNEAPOLIS, MINN., May 20, 1878. *State Chemist.*

Southward from the region of the Pipestone quarry the land continues high, and in some instances there are ridges, or long knolls, of drift, that are broad and evenly rounded over by a thin loam. The first exposure of the rock, in the vicinity of the road to Lu Verne, is on Sec. 13, T. 105, R. 46, along the south side of the valley that crosses westwardly near the centre of the section. It extends about a mile east and west. It here is seen to form an undulating floor on which the loam is thinly spread. It is hard, massive, pinkish-colored and superficially vitrified, in some places also showing two directions of glacial striæ, one being by compass nearly N. and S. and the other S. 52 deg. E.

The same line of rocky outcrop extends westwardly to the Splitrock creek, and along that creek and its eastern tributaries as far as it continues in the State. It seems to have a changeable dip, but nowhere presents perpendicular bluffs.

Two and a half miles further south on N. E. ¼ Sec. 36, is another exposure of the same rock, along a similar shallow ravine making westward—and again about half a mile further south on the high prairie.

At a point about ten miles north of Lu Verne this rock becomes frequently exposed both in the valleys and on the hills and continues so to the Mound, near Lu Verne, when it suddenly breaks off along the west side of Rock river, and is not known to the south of that place. Throughout this distance it forms a high plateau three or four miles wide and about a hundred feet higher than the prairies east or west, but the surface, though frequently rocky, is not rough. It is undulating ; and the plateau sinks gradually down tothe level of the rest of the country on either side. This plateau terminates abruptly in a rocky and precipitous bluff facing southeastward, three miles north of Lu Verne in what is known as "The Mound." There is a very large rocky outcrop in Secs. 4, 5, 6, 7 and 8, T. 103 N., R. 45 W. There are less frequent exposures in Gregory township, and the town next west. The Splitrock creek which crosses the northwest corner of Rock county has frequent exposures both in Rock and Pipestone ; but in Pipestone the rock range veers toward the east, into the centre of T. 104. R. 46 W., and disappears till reaching the region of the Pipestone quarry. In the N. W. part of Mound township the rock dips N. W. with a thrown, or twist, which, by slightly changing it, brings it soon below the surface. Indeed there seems to be a succession of ridges or swells, with changeable dip, though the most observable is to the northwest, about 10 degrees. These ridges are not covered with gravel or sand like similar ridges already mentioned east of the Coteau, under the operation of glacial forces, (ice and water) but while they occupy the grand divide of the county, they are nearly bare, on their tops and along their slopes, or are thinly covered with a gravelly loess loam, while the drift, even the stony clay that has been largely attributed to ice, occupies the valleys between to the thickness of at least 30 or 40 feet. On the top of some of these ridges, apparently near the top of this formation, the rock is conglomeritic. This occurs in large superficial areas, planed and smoothed down (rarely glaciated) and the colors of the pebbles, usually not larger than beans, give these spots a blotched and variegated mottling. The pebbles are mainly white, but some are jasper-red and some purple.

All over these ridges, which vary from a quarter of a mile to three or four miles in length, and are for the most part thinly covered with soil and turf, there are little nests of large blocks of quarzyte

piled so together that they seem to have been thrust up from below by some force. The edges of these blocks are squarely broken off, and slope toward each other, *i. e.*, toward the centre of the pile, while the blocks themselves lie so that their upper surfaces slope in all directions away from the center. Similar upheaved spots occur on the red quartzyte outcrop near New Ulm, and were described in the report for 1873. They were then attributed hypothetically to recent igneous forces. These upheaved spots vary from five to fifteen feet in diameter, or perhaps more. They may have been caused by ice, *i. e.*, alternate freezing and thawing with the change of seasons, aided by the force of vegetation and a little soil gradually getting into the openings.

At "The Mound," where this high land terminates abruptly, and faces the valley of Rock river, the elevation is about 175 feet above the river. The perpendicular bluff of rock is from 40 to 60 feet in its highest part; but owing to a dip of about 20 degrees from the horizon, nearly west, or partly northwest, and to the breaking off of the upper layers causing a gradual slope from the brow of the hill backward through several rods, the actual thickness of beds visible may be 150 feet. The rock here also appears to be almost entirely a reddish or pink, heavy-bedded, quartzyte. If wrought there might be some softer and thinner layers discovered in the angles of the talus, but the refractory nature of the great mass of it will cause it to be used but sparsely for building. The main bluff curves westwardly at both ends, and by reason of the dip and ravines that enter the valley from the west, its exposed layers gradually disappear under the soil in that direction, and the rock is lost in the prairie.

Near the base of the bluff of perpendicular rock, on a slope which descends to the river, once probably covered by the water of the river, on some of the lowest beds, the rock has the general shape of glaciation, but there are no striæ, the surface showing rather the action of water. On the top of the bluff are glacial striæ running S. 20 deg. W. by compass. Ten miles northwest of Lu Verne such marks run N. and S.

### *The Drift.*

The most important fact in connection with the drift of these counties is a gradual transition, from north to south, from drift clay, with stones and boulders to loam clay that has all the characters of the well-known loess-loam of the Missouri valley. The northern part of Pipestone county lies not far from the Coteau du Prairie,

which is a vast glacial noraine of drift materials, and is even affected somewhat in its contour by the westward decline of the Coteau to the prairie level. It is as characteristically a hardpan clay—the main mass of the drift, in this part of Pipestone county—as in any part of Minnesota. In traveling southward there is a gradual superficial change in all its characters. This change pervades at first but a small thickness of the deposit but by degrees involves the drift to the depth of 20 feet. At first there is a diminution in the number of visible boulders; then a smoothness in the creek bluffs; then a gravelly clay on the surface, fine and close; then a closeness in the prairie soil; then, in digging wells a few limy concretions are seen mingled with small gravelstones, and at last a fine, crumbling loam clay that cannot be distinguished from the loess loam, which extends to Sioux City in Iowa, and there *is known* as the loess-loam of the Missouri valley and has a thickness of several hundred feet. Wells dug in the southwestern part of Rock county demonstrate also a similar *perpendicular transition from loam to drift clay*, the former being true loess-loam and the latter true hardpan, or boulder clay. This appears like rank heterodoxy, but it is not a matter of opinion nor theory. It is the result of actual observation. The writer was as much surprised to find it as others will be to read it, and it appears almost inexplicable. The writer had abundant and favorable opportunity for observing this change in the grades and cuts of the new railroad from Lu Verne to the State line, and verified it in wells dug, and being dug, in that part of the county. In some places the loam passes below into a quicksand.

We have here then a series of changes by which, between the Coteau and Sioux City the loess-loam is produced from the drift hardpan, by the slow withdrawal of the stones and gravel, and the gradual predominance of water-action over ice-action, the Coteau being the limit of unmodified ice-action involving the whole drift sheet. It is not impossible that ice, in a broad sheet, underlay the surface, embracing the now underlying hardpan, while superficial waters disturbed and modified the surface of the drift for some distance south of the Coteau. Thus it seems that, by the agency of water very largely, a considerable tract of country was covered by drift which differs at first but slightly from the true hardpan, but at points more removed from the field of glacial action, becomes more and more clearly a water-deposit. This change could be observed only in a broad, level tract like southwestern Minnesota. This southward conversion of the stony and gravelly clay into the loess-loam must have been the result of copious drainage and wash from the northern drift, but a wash that seems to have been so gradual,

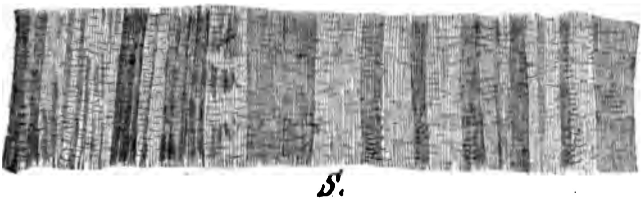
and yet so profound in its effect, as to have embraced at once a great thickness of the drift materials, causing them to flow more like a pasty mud at first, than water, but finally becoming simply a muddy water. This process is perhaps what covered the extensive buried soils and vegetable remains in Fillmore and Mower counties, beyond the limits of the last ice-period, without wholly disrupting them, and perhaps will account for the same phenomenon in Ohio and Illinois. It seems evident that the vast moraines of the northwest, where, in similar topography, the changes witnessed in the drift must be due to changed climatic conditions, mark great epochs in the history of the ice-age. There are two such that cross Minnesota, the older being the Coteau, and the younger the Leaf Hills. Corresponding to the latter the Kettle Range in Wisconsin seems a parallel phenomenon. [See also the report on Ramsey county.]

There is evidence of glacier-action, or what has been recognized as evidence of glacier-action, in Rock county south of the Coteau. The quartzyte is polished, striated, and sculptured superficially on the tops of the ridges in the central part of the county as only glacier-ice is known to do. At the Pipestone quarry, (near "The Three Maidens") such marks run 22 deg. W. of S. by compass. On the strike of the ledge at the same place they ran S. 10 deg. E. varying to 20 deg. W. of S. On Sec. 13, T. 105, R. 46 W. they run in two directions, one direction being nearly N. and S. and the other S. 52 deg. E. within the valley of a little stream. On the rock near the top of the southern side of this valley, which is a slight, shallow depression, glacial marks runs S. 22 deg. W. This is but a few rods from the last observation above. At another point, about ten miles north of Lu Verne, glacial marks were observed running nearly N. and S. On the rock at "The Mound" they run S. 20 deg. W. by compass. It seems almost impossible that in so level and open a country, and on the same rocks, without apparent cause, the glacier which must have been hundreds of miles wide, if it existed here at all, could have taken so diverse directions in so short distances. It cannot be doubted, however, that this marking was done by a force that exerted a great pressure at the same time that the marks were made. This pressure is evinced not only in the marking itself, which is on the hardest formation found in the State, but in the innumerable checks and flaws that cover the surface where this rasping has taken place, and yet leave it in the main a smoothed and rounded or *stossed* surface. These checks run curvingly downward at varying angles with the surface, and to all depths less than an inch, but usually less than one-sixteenth of an inch, and indicate perhaps an incipient crushing to the depth of at least an

inch. They show in what manner the rasping reduced the original projecting knobs. Where the natural seams or planes of jointage cross the rock, these little checks are larger, causing the quartzyte to chip off sooner and deeper with a curving and choncoidal fracture. This prevailing direction is transverse to the crushing force, so that the rock, along some grooves, has a short conchoidally laminated structure transverse to the grooves, penetrating it to the depth of a quarter to half an inch, exhibited now in a series of little curving furrows where the laminæ broke off successively, the concavities of the laminæ being toward the north.

FIG. 10.

N.



S.

Striated red quartzyte in Rock county.

This marking is represented in Fig. 10, but the figure does not show a great many fine checks with which the surface of the rock is nearly covered, but it shows correctly the prevailing direction of the curvature, and its relation to the moving force. This manner of glaciated marking is visible on Sec. 13, T. 105, R. 46, and also on "The Mound," near Lu Verne. It can be compared to a cross-grained planed board, where the plane has been driven against the grain, except that the cut edges are curved so as to present their concavity toward the cutting or planing force.

It has already been mentioned that there are but few boulders in Rock county. They are generally confined to the creek bluffs and valleys. Even on the plateau caused by the red quartzyte running from near Lu Verne northwestward they are not seen, or are so rare as to be noteworthy. This is an anomaly. In ice-covered regions, *i. e.* in regions known to have been last passed over by the ice of the drift epoch, there would be no place where foreign boulders would be found more thickly than on such rocky elevations.

In traveling over the plateau of quartzyte, about on Sec. 16, Mound, one large solitary granite boulder may be met with. It lies directly on the quartzyte. It is rough and granulated, and there is a circular excavation or concavity in the soil in which it lies. It is about ten feet long and five feet high, and has a groove horizon-

tally circumscribing it about a foot in width and three or four inches deep. Taken altogether it immediately reminds the beholder, not less by its general shape than by this groove, of the *stone hammers* sometimes found. Its size precludes its being one, but its shape is very like them. The groove may have been formed by the action of ice and water on its sides, as it has the appearance of lying in ordinary seasons in a little lake of water, which at the time of this examination was entirely dried up. This boulder, like the "Three Maidens," at the Pipestone quarry, must be referred to the date of the boulder clay, and in that case it was not disturbed by, but probably witnessed, the spreading the loam which came later.

The "Three Maidens," and the three others (smaller) that make up the cluster of six granite boulders lying just outside the Indian Reservation at the Pipestone quarry, also rest on the surface of the red quartzyte about 60 rods southeast of the quarry and at the foot of the long ledge or escarpment that passes north and south. They evidently once constituted one immense boulder and have become six from the falling apart, under the influence of frost, of the granite along its natural seams or joints. Such a separation of large boulders is sometimes seen on the prairies in Minnesota under circumstances which demonstrate their former entirety.

On the surface of the glaciated quartzyte about these boulders, which is kept clean by the rebound of the winds, are a great many hieroglyphic inscriptions, which were made by pecking out the rock with some sharp-pointed instrument. They are of different sizes and dates, the latter being evinced by their manner of crossing and interfering, also by a difference in the weight of the instrument used. They generally represent some animal, such as the turtle, wolf, bear, badger, buffalo, elk, and the human form. The "crane's-foot" is the most common. They are very similar to those represented on Plates XI and XII of Vol. II, of the "Bulletins of the U. S. Geol. and Geog. Sur. of the Territories," accompanying the article of W. H. Holmes on Ancient Ruins in Southwest Colorado. The Indians regard the "Three Maidens," represented by the three larger boulders, as the maids from whom the tribes sprung after the destructive anger of the Manitou had slain the people. It would seem as if any warrior or hunter who had been fortunate in the chase and happened to pass here, left his tribute of thanks to the Great Spirit in a rude representation of his game, and perhaps a figure of himself, on the rocks about these boulders. In some cases there is a connection of several figures by a continuous line, chipped in the surface of the rock in the same manner, as if some

legend or adventure were narrated, but for the most part the figures are isolated. This is the "sacred ground" of the locality. There are hieroglyphics at no other place around here, though there is abundance of bare rock.

*Common Wells in Rock County.*

The water of wells in the loam, or in the drift-clay, is very hard. This is caused by a large amount of limestone gravel disseminated through all the materials of the drift, derived from the limestones of Winnipeg. There is occasionally a water which has a distinctly alkaline character, but this is not common. Nearly all the wells of the county are curbed with pine boards, and from that fact great numbers of them are contaminated with the organic decay known to result from that practice, and a number were examined that were very foul from that cause. Several recent cases of typhoid fever at Lu Verne are directly referable to that cause, and no doubt, if the facts could be known, many others in the country could be accounted for in the same way. The curbing of wells in the prairie regions with pine boards or planks is very common, owing to the lack of convenient stone, and the ease of constructing such curbs of wood; but it is a practice which all well-diggers should loudly and persistently protest against, and which all the owners of wells should discontinue, as it is a fruitful source of foul water, causing intestinal diseases and typhoid fevers. The adjoined table shows the depth and character of some of the wells of the county.

## *Wells in Rock County.*

| Owner's Name. | Location. | Depth—feet. | Remarks. |
|---|---|---|---|
| A. L. Marsh | S. W. ¼ Sec. 4, Lu Verne | 33 | Only seep water; water hard; "joint clay" all the way, more compact in the bottom. |
| —— Stone | Lu Verne | 13(?) | Sandy loam, then loose stones, some large, 6 ft.; gravel 8 in.; pebbly clay 7 ft.; then blue clay. |
| —— Taylor | N.E. ¼ Sec. 10, Lu Verne | 84 | No water. Loamy sand, with stones; pebbly clay, becoming blue at 24 ft.; blue clay 15 ft.; fine, dry sand; a shell (described like a common fresh water clam) and wood were taken out at 52 feet in this sand, which is clayey when wet, and fine like flour when dry. (This may be the Cretaceous.) |
| W. O. Crawford | S. E. ¼ Sec. 20, Beaver Creek | 28½ | Abundant good water in quicksand; in "the lower edge" of the stony blue clay, twenty feet below the surface, a stick with grain like elm was taken out. |
| —— Kennedy | N.W. ¼ Sec. 35, Lu Verne | 42 | Poor water; a dangerous gas gathers in this well; cedarwood found at 38 feet. |
| —— Taylor | N.E. ¼ Sec. 10, Lu Verne | 12 | Loam; gravel; "fine dry sand," which sparkles in the sun; this sand is so fine as to be water-tight, and to make a reservoir for water, and may be of the Cretaceous. |
| Peter Webber | S.W. ¼ Sec 8, Lu Verne | 42 | At first no water, but afterward filled to within 10 feet of the top with a poor (alkaline) water; "joint clay" all the way, with crystals of gypsum. |
| Worthington & Sioux Falls R.R. | Sec. 17, Lu Verne | 15 | "Joint clay"; loose stones and gravel with water; "red clay" below the gravel. |
| Samuel Spalding | Sec. 20, Lu Verne | 28½ | "Joint clay or red clay"; then blue clay; water from a sand vein in "joint clay." |
| —— Shively | Kanaranza | 22 | Good water from sand at 18 feet, under "joint clay." |
| Henry Halbut | Magnolia | 30 | Seep water, good; "joint clay" all the way. |
| E. Sheldon | Beaver Creek | 18 | This is in the general valley of Beaver Creek, between two ravines; good water; six feet sandy loam; six feet stones and gravel; two feet shells and sand (these shells were Unio and were soft and rotten); two feet blue clay, containing wood. |
| Lary McDermott | Mound | 25 | Good water; struck the rock under gravel and sand. |
| Samuel Spalding | Sec. 20, Lu Verne | 10 | Good water in gravel. |
| C. R. Henton | Sec. 22, Beaver Creek | 48 | Loam; blue clay; good water from sand layer in the blue clay; stone curbing. |
| W. T. Henton | Sec. 30, Beaver Creek | 68 | Loam; blue clay; stopped in blue clay; water foul from the wood curbing. |
| C. Williams | Sec. 28, Beaver Creek | 36 | Loam; blue clay; water seeps. |
| Wm. Grout | Sec. 24, Beaver Creek | 24 | Loam and clay; good water; the clay was all gravelly, except the very surface soil, with little bunches of sand; water seeps. |
| Lu Verne House | Lu Verne | 16 | Good water in gravel. |

*Material Resources.*

These counties contain some of the best farming lands in the state. They are not broken by rock exposure (except through the central part of Rock county), so that nearly all their area is tillable. The rocks that underlie them are not known to hold anything of great economical value. They will serve as a building material, but are rather hard even for that, and it may be found more economical to bring in by railroad the building stones of the eastern counties. The main material product of these counties is now, and will always remain, *wheat*, of which they will produce as much to the acre as any county in the State.

# VII.

## PALÆONTOLOGY.

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*Notes on the Fossils of the Trenton in Minnesota.*

During the month of July, 1877, some time was given to the examination and arrangement of some of the fossils of the Trenton in the collections of the survey, continuing thus the work begun the season before. As but little time could be had for this part of the work of the survey, the results are meager. The fossils represented by the following list are additions to those named in the report of last year. It was found that a greater range of authorities for reference was necessary for the reliable identification of our specimens, and measures have been taken for procuring many foreign and American works, containing descriptions of the fossils of this horizon.

By reference to the Museum Report accompanying this, the corresponding numbers of the Register will be seen, and other particulars of each species ascertained.

No. 90. *Asaphus extans, H.?* (Compare No. 399). This specimen has been in the museum a number of years, and its origin is unknown; but its similarity to specimens obtained of Mr. W. D. Hurlbut, from Trenton Falls, N. Y., renders its source less doubtful. It is probably from the Trenton formation in Minnesota. It has a tuberculated surface instead of a lamellose one, as *A. extans* is described by Hall.

No. 172. This block contains fragments of the crinoid of Hall, *Schizocrinus nodosus*, with an unidentifiable species of *Murchisonia*, and fragments of a trilobite. *Locality*, Pleasant Grove, Olmsted county.

No. 185. Slabs containing *Strophomena*, *Orthis*, *Chætetes*, *et al.* Fillmore county.

No. 186. *Orthis perreta Con.* These are considerably larger than the type specimens. They are from Taylor's quarry near Fountain, Fillmore county.

No. 189. Fragments of *Asaphus gigas, H.* From Fillmore county.

No. 191. Slab with *Leptæna sericea, Sow. Orthis emacerata, H. Strophomena filitexta, H. and Strophomena, nitens, Bill.*; from Fillmore county.

No. 192. *Poteriocrinites caduceus, H. Orthis testudinaria, Dal. Rhynchonella capax, Con.* are also from Fillmore county.

No. 197. This is provisionally named *Othoceras laqueatum, H.* but the agreement is not satisfactory. *Locality*, Spring Valley, Fillmore county. (Compare No. 214.)

No. 208. *Strophomena tenuistriata.(?)* Compare Nos. 204 and 371. *Locality*, Sec. 17, Rochester, Olmsted county.

No. 214. This slab shows *Leptæna sericea, Sow. Murchisonia bicincta, H. Orthoceras laqueatum, H. Bellerophon bilobatus, Sow. Strophomena, nitens, Bill.* and *Rhynchonella capax, Con. Locality*, Spring Valley, Fillmore county.

No. 242. *Cyrtoceras arcuatum, H.* has been obtained from Holden, Goodhue county.

No. 243. *Oncoceras constrictum, H.* is from the same locality.

No. 252. *Orthoceras vertebrale, H.* is from the same locality.

No. 269. *Orthis subquadrata, H.* has been identified from Sec. 30, Forestville, Fillmore county.

No. 293. *Strophomena fluctuosa, Bill.* is found in the upper layers of Willson's quarry at Mantorville, Dodge county, which is in the Galena.

No. 294. *Graptolithus scalaris, Linne* is found in the same layers.

No. 297. *Discina Pelopea, Bill.* is found in the same layers. Compare No. 263.

No. 307. *Chætetes petropolitanus, Pan. ?* is found on Sec. 21, Forestville.

At Minneapolis have been identified different forms of *Rhynchonella capax, Con.* and of *Orthis perveta, Con.* The following have also been found at Minneapolis: *Orthis emacerata, H. Var. multisecta, James. Chætetes Lycoperdon, H. Murchisonia bicincta, H. Pleurotomaria subconica, H. Schizocrinus nodosus, H. Cyrtolites compressus, Con.* and *Bellerophon bilobatus, Sow.*

No. 348. *Cyrtolites compressus, Con.* occurs on Sec. 16, Pleasant Grove, also *Orthoceras strigatum, H.* (Nos. 350 and 381.)

From Pleasant Grove, Olmsted county, also comes *Oncoceras constrictum, H.* (No. 352).

No. 376. *Asaphus gigas, H.*—from St. Charles, Winona county.

No. 397. *Orthoceras vertebrale. H.*—from St. Charles, Winona county.

No. 392. *Orthis bella-rugosa, Con.*—from St. Charles, Winona county.

No. 399. *Asaphus extans, H. (?)* (Compare No. 90). This specimen was obtained of W. D. Hurlbut, and is from Trenton Falls, N. Y. It differs from Prof. Hall's description of *A. extans* in having a surface rather pustulated than lamellose.

No. 410. *Asaphus gigas, H.* and *Strophomena filitexta, H.*—from St. Charles, Winona county.

# VIII.

# REPORT ON THE GEOLOGY OF RICE COUNTY.

BY L. B. SPERRY.

### *Situation and Area.*

The northern border of Rice county is about 35 miles south of St. Paul, and its eastern border is about the same distance west of Lake Pepin. It is bounded on the north by portions of Dakota and Scott counties; on the east by Goodhue county; on the south by portions of Steele and Waseca counties, and on the west by Le Sueur county. It is four Government townships, or 24 miles, in width east and west. The western portion of the county is of the same length—24 miles north and south—but the eastern two tiers of townships are shorter by 5 miles.

The county contains 14 townships, each of them, except two, containing 36 square miles. Of these two exceptions, one, Bridgewater, contains 40 square miles, and the other, Northfield, 44 square miles.

Its area then is 330,240 acres, of which nearly one-half is timber land interspersed with many lakes.

There is but very little land in the county unfit for tillage.

That portion east of the Straight and Cannon rivers is the finest of prairie land, while most of that west of these rivers is, or was originally, covered with valuable timber, which, on being removed, leaves a strong and fertile soil.

Fairbault is the county seat. Northfield, Morristown, Dundas and Shieldsville are the principal towns.

*Natural Drainage.*

The drainage of the county is to the north and east. Straight river enters the county 2½ miles east of the middle of the southern border, and, flowing northward about 8 miles, forms a junction, (where the city of Fairbault now stands) with the Cannon river, which enters the county about 2 miles north of its southeast corner. From the junction of the Straight and Cannon rivers—taking the latter name—the waters flow northward and leave the county 4 miles east of the meridian line upon which the Straight river enters its borders. The western half of the county contains about a score of shallow but pretty lakes, which receive the surface waters of their localities, and empty for the most part by very circuitous routes into the Cannon. The Straight and Cannon also receive the drainage from the eastern portions of the townships through which they flow; while the eastern tier of townships, for the most part, shed their waters through small streams into the Little Cannon and Zumbro rivers in Goodhue county. The Straight river enters the county in the Lower Trenton formation, and cuts through into the St. Peter sandstone 3 miles north of the county line, near Walcott's mill.

A short distance from Walcott's the river makes an extensive bend toward the south, and on reaching Faribault has cut 80 feet into the sandstone.

At a point near the line separating Bridgewater and Cannon City townships the river has cut through the St. Peter sandstone and begins its flow over the Shakopee limestone, into which it has cut about 30 feet when it leaves the northern boundary of the county.

This descent of about 150 feet in crossing the county furnishes at least eleven available mill privileges which have been improved and are in operation.

The following tabular exhibit shows the most important and interesting facts relative to these:

*Water Power Mills in Rice County.*

| Name of Mill. | Owner. | Location. | Stream. | No. of feet fall. | Run of Stone. | Barrels daily. |
|---|---|---|---|---|---|---|
| Walcott | Chaffee & Sheffield | 5 miles South of Faribault | Straight R. | .... | 4 | 100 |
| Straight River Mills | J. D. Greene & Co. | Faribault | Straight | 13 | 3 | 60 |
| Kendall | Greene & Gold | Faribault | Straight | 7½ | 4 | 80 |
| Matteson's | H. M. Matteson | Faribault | Cannon | 6 | 4 | 80 |
| Polar Star | Stock Co | Faribault | Cannon | 8 | 7 | 150 |
| Warsaw | | Warsaw | Cannon | 5 | 3 | 50 |
| Hershey's | C. Hershey | Morristown | Cannon | 7 | 2 | Custom. |
| Roberds Lake | J. G. Scott | Outlet Roberds Lake | | 15 | 2 | 50 |
| Cannon City | R. H. Scott | Ne'r Cannon City | Cannon | 7 | 4 | 100 |
| Dundas Mills | E. T. Archibald & Co. | Dundas | Cannon | 9 | 8 | 200 |
| Northfield Mills | Jesse Ames & Son | Northfield | Cannon | 10 | 10 | 200 |

*Surface Features and Soil.*

The eastern portion of the county is, for the most part, a high and gently rolling prairie of great beauty and fertility.

Skirting the small streams there is a little timber, and along the east bank of the Straight river—and also of the Cannon, from its junction with the Straight northerly to Dundas—there is a belt of timber averaging about 3 miles wide. The soil bearing this belt of timber is sandy with gravel subsoil, and is of comparatively little value for agricultural purposes.

The surface of the southwest part of the county lies above the Trenton formation and is gently undulating.

The surface of the northeast part is more broken because the Trenton is largely carried away and the St. Peter sandstone is eroded to quite variable depths.

The western portion of the county also is quite undulating—sometimes rough and hilly—and over the greater part is covered with heavy timber, interspersed with many beautiful but shallow lakes.

The surface soil is usually a dark loam, but is generally very thin. A strong and productive yellow clay overlying thick deposits of blue clay—which is frequently exposed—characterize the soil of this region. Maple, Elm and Basswood characterize the timber.

There are about twenty beautiful lakes in the western half of the county, ranging from one to ten square miles in area, and varying from ten to fifty feet in depth. These lakes abound in fish and are much frequented by sportsmen.

The southwestern part of the county, being lower and more sandy, furnishes better beaches for its lakes than are found further north where clay deposits overlie and conceal the sand.

I am under obligation to Surveyor Jewett, of Fairbault, through whose kindness I secured the following:

## SURVEYOR'S NOTES OF RICE COUNTY.

### *Township 109, Range 19.*—Richland.

Rolling prairie. Soil a black loam with clay subsoil. The north branch of the Zumbro river flows easterly through the northern part, taking the surface water of nearly the whole town.

### *Township 110, Range 19.*—Wheeling.

Surface rolling, becoming bluffy along the creek. The east branch of Prairie creek heads near the center of the town, where there is a body of about one section of timber. This creek flows northeasterly, and forms a valley from one-eighth to one-fourth of a mile wide, about fifty feet below the general level of the prairie. From the bluffs along this valley in the north part of the town limestone crops out with sandstone below.

### *Town 111, Range 19.*—Northfield.

Surface mostly a high rolling prairie sloping toward Prairie creek, which runs northeasterly through the township; a part of the town is drained northwesterly toward Cannon river. Soil a rich black loam; clay subsoil; limestone in bluffs along the creek; sandstone below.

### *Town 109, Range 20.*—Walcott.

Surface rolling to hilly; slopes toward Straight river, which runs northerly through nearly the center of the town; a body of timber three to four miles wide lies on the east side of the river. Limestone appears in the bed of the river as far north as Sec. 4. North of this point it appears in the bluffs from 20 to 50 feet above the river. Soil in the river valley light and sandy with gravel subsoil; rest of town black loam over clay.

### *Town 110, Range 20.*—Cannon City and Faribault.

Surface quite rolling; bluffy along the east side of river. The Straight river forms junction with the Cannon river in Section 30, from which point the Cannon river runs northeasterly to the centre of the north boundary. The two eastern sections are prairie; the remainder of the town is timber land: soil a rich loam with clay subsoil. Limestone crops out of river bluffs with sandstone below; a small lake in Sec. 15, containing 45 acres.

### *Town 111, Range 20.*—BRIDGEWATER.

Land rolling; becomes bluffy along the river as far north as Section 10. Cannon river flows northeasterly through the eastern part of the town. About six sections on east side of town are prairie; rest of town timber land; soil black loam with clay subsoil, excepting on river bottoms, where the soil is light and sandy over a gravelly subsoil; limestone in the bluffs along the river south of Section 10. In Section 1 it appears in the bed of river.

### *Town 109, Range 21:*—WARSAW.

Surface rolling; drains toward the north; Cannon lake, with an area of 1475.28 acres, lies in the northwestern part of the township; four sections of land northwest of lake are timber land; rest of town is prairie and brush land; soil black loam over clay subsoil.

### *Town 110, Range 21.*—WELLS.

All timber land excepting Sections 35 and 36; surface rolling; soil black loam with clay below; area of meandered lakes 2114.44 acres; drains toward the south.

### *Rown 111, Range 21.*—FOREST.

All timber land; surface rolling; draining eastward; soil black loam, clay subsoil; area of lakes, 1694.41 acres.

### *Town 112, Range 21.*—WEBSTER.

Timber and brush land; surface rolling: drains to the south and east; soil light-colored loam over clay. Area of meandered lakes, 208.81 acres.

### *Town 109, Range 22.*—MORRISTOWN.

Nine sections in southeast part prairie land; remainder of town timber. Cannon river flows easterly through the center of township; surface rolling, slopes towards the river; soil a rich black loam with clay subsoil. Area of meandered waters, 935.70 acres.

### *Town 110, Range 22.*—SHIELDSVILLE.

Surface rolling, becoming hilly in some parts of the town: soil black loam over clay. Area of lakes, 2574.23 acres. The Cannon river heads in Tuft's lake, in Section 3.

### *Town 111, Range 22.*—ERIN.

Surface rolling to hilly, timber and brush lands; soil rich loam over clay. Area of lakes, 856.32 acres.

### *Town 112, Range 22.*—WHEATLAND.

Surface rolling and hilly; soil black loam on clay subsoil; timber and brush land. Area of lakes, 307.27 acres.

## *Timber.*

As before stated the eastern portion of the county originally produced timber only along the streams. Through cultivation for shade, hedges, protection from winds, &c., timber is increasing over this area.

The western half of the county was originally covered with heavy timber—excepting a few limited, enclosed spaces, which were open prairie, or sparsely covered with oak and under-brush—and forms a part of what is denominated the "Big Woods."

This region is being cleared up rapidly and there are now many fine farms in every township of the timber regions of this county.

The following list embraces all the native trees and shrubs that were noticed during the survey. It is not believed, however, that it includes all that grow naturally in the limits of the county :

Basswood. Tilia Americana. *L.*
Smooth Sumach. Rhus glabra. *L.*
Jersey Tea. Ceanothus Americanus. *L.*
Sugar Maple. Acer saccharinum. *Wang.*
Silvery Maple. A. dasycarpum. *Ehr.*
Red or Swamp Maple. Acer rubrum. *L.*
Box-Elder. Negundo aceroides. *Mœnch.*
False Indigo. Amorpha fruticosa. *L.*
Locust. Robinia Pseudacacia. *L.* Cultivated.
Cherry. Prunus.
Red Raspberry. Rubus strigosus. *Michx.*
Blackberry. R. villosus. *Ait.*
Crab. Pyrus arbutifolia. *L.*
Dogwood. Cornus paniculata. *L'Her.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Ash. Fraxinus.
Slippery Elm. Ulmus fulva. *Michx.*
Butternut. Juglans cinerea. *L.*
Walnut. Juglans nigra. *L.*
Hickory. Carya.
Burr Oak. Quercus macrocarpa. *Michx.*
Black Oak. Quercus coccinea. *Wang.* Var tinctoria. *Bartram.*
Wild Hazle-nut. Corylus Americana. *Walt.*
Iron-wood. Ostrya Virginica. *Willd.*
American Aspen. Populus tremuloides. *Michx.*
Cottonwood. P. monilifera. *Ait.*
Large-toothed Aspen. P. grandidentata. *Michx.*
Balm of Gilead. P. balsamifera. *L.* Var. candicaus. *Ait.*
Red Oak. Quercus rubra. *L.*
White Oak. Quercus alba. *L.*
Wild Plum. Prunus Americana.
American Elm. Ulmus Americana. (*Pl Clayt.*) *Willd.*

American Crab. Pyrus Coronaria. *L.*
Black Cherry. Prunus serotina. *Ehr.*
Bitternut. Carya amara. *Nutt.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*
Thorn Apple. Cratægus Crus-galli. *L.*
White Birch. Betula alba. *Var.* populifolia. *Spach.*
Small Cedar. Juniperus Sabina. *L.* *Var.* procumbens.
White Pine. Pinus Strobus. *L.*
Water Beech. Carpinus Americana. *Michx.*
Cornel. Cornus paniculata. *L'Her.*
Cornel. Cornus circinata. *L'Her.*
American Woodbine. Lonicera grata. *Ait.*
Juneberry. Amelanchier Canadensis. *Torr & Gray.*
Dwarf Wild Rose. Rosa lucida.
Pipe Vine. Aristolochia Sipho.
Grape. Vitis cordifolia. *Michx.*
Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Nine Bark. Spiræa opulifolia. *L.*
Bittersweet. Celastrus scandens. *L.*
Rose. Rosa blanda. *Ait.*
Lombardy Poplar. P. dilitata. *Ait.*
Speckled Alder. Almus incana. *Willd.*

## GEOLOGICAL STRUCTURE.

In general the drainage of Rice county is toward the north and east, which fact indicates the relative elevations.

The Chicago and Milwaukee R. R. survey (Minnesota Div.) found the elevations of the natural surface, where the railroad crosses the northern line of the county, to be over 1050 feet above the sea level. At Faribault depot it is 993 feet; at Dundas depot, 945 feet; at Northfield depot, 905 feet. The entire western half, and the southeastern portions of the county have a higher elevation. I have no means of knowing positively the relative elevations or the highest point in the county; but judging from appearances I conclude that the rolling prairie, on which Cannon City is located, is the highest by least 100 feet.

The only geological formations that appear in this county are the

Loam,
Drift,
Trenton Limestone,
St. Peter's Sandstone,
Shakopee Limestone.

In *general appearance* these formations are not unlike the same formations as they are seen in other portions of the State, and carefully described by Professor Winchell in his reports made during the past few years. Nor did I find in the county any remarkable *special peculiarities* in any of the formations.

The *Loam* is deep, dark-colored and fertile, over nearly all the eastern portion of the county; but over the western portion as a rule it is thin.

Drift, consisting largely of blue clay over-lain by a grayish yellow clay, characterizes the soil of the western half of the county. Boulders of granite, gneiss, trap and porplyry are quite abundant in some places; but fine clay, with small quantities of gravel, are the rule throughout this region. No well yet dug in the western part of the county has passed through the blue clay—though some of the wells are over 100 feet deep. A hint as to the depth of the clay is found in the fact that a well dug last season south of Rice county, about 30 miles west of Owatonna—near Janesville—after passing through 200 feet of blue clay reached a sandstone said to be identical with the St. Peter's in appearance. An abundance of good water, which rose to within 30 feet of the surface, was found between the clay and the sandstone. This fact should be considered by the residents of this drift and timber region, as many of them have failed to secure good and abundant water in the clay. Indeed there is much uncertainty about getting *good* well water in this region. Some holes at 100 feet or over fail to bring enough water for drinking and cooking purposes. Some wells that furnish an abundance of water are so strongly impregnated with mineral impurities as to be nearly useless, while others are quite pure. It is possible that good water which would rise nearly to the surface might invariably be procured by boring through the clay to the under-lying rock.

Illustrations of the peculiarities of the deposits in this region are seen in the following facts: On the S. E. side of Union Lake (7 miles west of Northfield) Mr. B. Benton dug 40 feet and secured an abundance of water, but is strongly impregnated with some mineral impurities. About 40 rods from there Mr. M. J. Punk secured better water at 16 feet; and about 40 rods further Mr. S. A. Amsden secured nearly pure water at a depth of 36 feet.

It has been supposed by some that the formation underlying the drift throughout the timber region is the Cretaceous, and I see that Prof. Harrington in his report on Steele county expresses his belief in the existence of the Cretaceous along that belt. I am not satisfied that such is the fact. To my mind there is but very little

evidence of it; but I do not desire to discuss ths matter till I have procured more light on the subject. At present my belief is that the drift rests immediately upon a thin remnant of the St. Peter sandstone. Perhaps in some places the St. Peter is all eroded so that the drift rests immediately upon the Shakopee.

Reference to the accompanying colored map of the county will show the areas of the different formations as they give evidence, by exposure and by topography, of underlying the deposits of drift and loam.

It will be seen that the Trenton limestone is nearly removed from the western part of the county, the bluffs along the Straight river to a point a little south of Faribault, and a hill near Northfield, being the only places where it occurs. East of the river, however, it is extensive, and furnishes abundance of material for building purposes of which mention will be made under the head "Material Resources."

In general character the Trenton resembles so closely that found in other parts of the State, and so carefully described in previous reports on the survey of the State, that little need be said here.

For building purposes the most of that found in this county is superior to that quarried near St. Paul, in that it contains less clay and does not weather so easily. On the other hand the Rice county limestone contains more concretionary iron pyrites, and, hence, necessitates more care in its selection for architectural purposes.

The Straight river cuts through the Trenton and enters upon the St. Peter at Walcott's mill, 3 miles south of Faribault. At a point eight miles further north the river (having now become the Cannon) has worked its way through the St. Peter and enters upon the Shakopee. The thickness of the St. Peter, in Rice county, is from 100 to 125 feet. It appears in the form of cliffs at frequent points along both sides of the river from the place where it is first reached by the Straight to the northern limits of the county, and in the northeastern part of the county it frequently appears in the hills—indeed it largely gives character to the topography of this section.

Judging from the topography also I am satisfied that many of the hills in the northwestern part of the county—in Wheatland and Webster townships—consist largely of the St. Peter; but they are so heavily covered by drift and timber that I could neither find nor learn of any exposures. In Cedar Lake there is an island the topography and flora of which indicate the St. Peter, capped with Trenton. I was unable to verify this by excavations.

There is no place in the county where the St. Peter sandstone is sufficiently compact and firm for building stone. As along the

Mississippi, it may be removed by pick and shovel. In color it is—as along the Miss. river—white to red, according to the percentage of iron, and its oxidation resulting from exposuse. No fossils are found in it here.

The Shakopee limestone is reached by the Cannon river at a point about 4 miles south of Dundas—6 milns south of Northfield. On leaving the county one-half mile north of Northfield, the river has cut into the Shakopee about thirty feet. The map shows approximately the extent of this formation as exposed. The descriptions of it in preceding reports will apply to the formation as seen here.

*Material Resources.*

Limestone—both for building-stone and for quick-lime—and sand for mortar, are abundant along the valleys of the Cannon and Straight rivers, and throughout the western half of the county; while in the western portion no limestone is found.

Good clay for the manufacture of brick is sufficiently abundant all over the county.

*Stone Quarries*

are abundant throughout the eastern half of the county. The bluffs throughout this region are capped by a layer of the Trenton, varying from a few inches to several feet in thickness.

The various neighborhoods of this section have their quarry, or quarries, from which all the building stone for general purposes is easily obtained.

Prairie Creek Valley has scores of quarries opened along its bluffs; and the valley of the Cannon looks up to as many more. Good coursing-stone is furnished at Northfield for about $6 00 per cord.

At "Fall Creek," 3 miles east of Faribault, there is a fine deposit which is being extensively quarried by its owner, Mr. Phillip Cromer. The deposit of limestone here is about 12 feet thick and is covered by about 4 feet of drift and loam. The strata in this quarry range from 3 to 12 inches in thickness and are easily quarried. The upper stratum, 8 inches in thickness, is quite light-colored and filled with fossils which are so thoroughly cemented and transformed as to render the stone compact, while its fossiliferous nature is still clearly apparent. But few specimens of fossils can be enucleated. The rock is infiltrated by gypsum and Iron Pyrites which often cement its seams quite firmly.

Mr. Cromer sells undressed stone for prices ranging from $5.00 to $15.00 per cord. The greater part of his business however is in the best varieties, which he sells by the cubic foot, at prices ranging from 25 cents to 75 cents.

Mr. N. Lord, 2 miles south of Faribault on the west side of the river, has two quarries opened, from which he has sold as high as 300 cords in one year.

In Richland township, bordering on Goodhue county, Messrs. Halver Johnson and Peter Halverson have each a fine quarry at which I saw about 100 cords ready for market.

Messrs. I. Lenhart, A. Revere, C. Stetson, D. Furguson and P. Oleson are the principal quarrymen in the vicinity of Northfield; and on Prairie Creek, in Wheeling township, Messrs. J. Thompson, A. Knapf and S. Aslagson do quite an extensive business in quarrying for their neighbors.

### *Lime Kilns.*

The upper four strata of the Lower Trenton formation as exposed in this county furnish tolerably good material for quick-lime, though in some places the deposit is too silicious, and in no place is the lime obtained sufficiently white for fine work. When first burned the lime is yellowish in color, but when slacked is nearly white. It is excellent lime for stone work.

Though lime has been burned in every township of the county east of the Cannon river, it is not now made a regular and paying business except at Phillip Cromer's kiln, on Fall Creek, near Faribault. Mr. Cromer uses a patent kiln and burns from 3,000 to 3,500 barrels a year, which he sells at 65 cents per barrel. Three other kilns near Fairbault, owned respectively by Messrs. Pond, Lee and Lord, burn in the aggregate about 1,000 barrels per year. There is a kiln one mile from Northfield, in Dakota county, which supplies Northfield and vicinity. This kiln burns its lime from the best strata of the Shakopee formation. In general character the lime is like that of the Trenton.

### *Brick.*

Rice county contains an abundance of clay for the manufacture of brick but none has been found sufficiently free from iron to make the white or cream-colored brick. At Faribault Mr. J. G. McCarthy makes about 700,000 per year, which he sells at $6.00 per thousand. One season he made one million. All the clay of this section is so clear that to make good brick it is necessary to add sand.

Henry Durham, of Faribault, burns about 300,000 per year and finds lying immediately under the clay a stratum of sand for mixture with it.

Another brickyard has been started at Faribault this season. Its character and success are not determined. At Prairieville, Messrs. Meisner and Leonard are making about 300,000 per year. Their brick are said to contain considerable lime and to be very good. At Morristown, Mr. Pettiel makes abont 50,000 per year. Three miles northeast ot Faribault, Mr. Dungay is making the best brick yet produced in the county. His product so far has been but about 100,000 per year, but these have been sold at from $7.50 to $8.00 per thousand. At Shieldsville one kiln is burned each year for home supply, and at Northfield one or two small kilns are burned every season.

During the past season a bank of clay has been opened about three miles from Northfield and brick for the new college building (St. Olaf's) have been burned. They are pronounced of fine quality.

In making the survey of this county I am especially indebted to Surveyor Jewett, of Faribault, for surveyor's notes of the county, to Professor J. J. Dow of the State Blind Asylum, at Faribault; for his valuable company and assistance during several of the days occupied in field work, and to Professor B. F. Thomas of Carleton College, who also rendered valuable assistance.

At some convenient time in the future I shall hope to make a *supplementary report* concerning some further facts and features pertaining to the Geology of this county.

# IX.

## CHEMISTRY.

### REPORT OF PROF. PECKHAM.

*Prof. N. H. Winchell,*

MY DEAR SIR:—The chemical work for the Geological Survey during the last year has been as follows:

The analysis of the ashes of 17 specimens of peat.
The analysis of four specimens of peat as fuel.
The analysis of the water of the Belle Plaine salt spring, so-called.
The examination of 13 specimens of water from the Red River Valley.
The examination of 3 specimens of water from Brainerd.
The examination of three specimens of limestone, and of concretions from the brick clay at Minneapolis.

The results of the examination of the peat and peat ashes are herewith submitted. The water from Belle Plain was procured by myself about the first of last May. On reaching Belle Plaine I enquired for the spring from which the salt water had formerly been obtained and was informed that the bank had caved in upon it and it was filled up with earth. I was further informed that the water oozing from the base of the bluff was as salt as any water about there. I then enquired about the well and the possibility of getting some water from the boring. I was informed that no water could be procured from that source as the pump had been taken out and the level of the water was many feet from the surface. The station agent confirmed this information and I saw no other resource but to collect such water as I could from that flowing from the bluff. I brought this to the Labratory and soon found that this specimen was nothing more than hard well water, confirming the results of the examination that I made in 1873-4. I afterwards met a gentle-

man who resided in Belle Plaine, who confirmed the statement previously made to me that I had probably got a specimen of as salt water as any that was to be had there now.

Having ascertained that there was a comparatively small amount of solid matter in the water, of which only a very small proportion was chlorides of any kind, that the water contained principally bicarbonates of lime and magnesia with some sulphates and chlorides; in fact, as stated above, that the water was nothing but a hard well or spring water, I concluded that it would be useless to make an estimate of the gasses dissolved in the water, or of the substances contained in small quantity, and therefore after completing the estimates then begun I did not continue the examination further.

But one of two conclusions can be entertained in reference to these results; either the wrong water has been examined or the Belle Plaine salt springs do not yield salt water. I purposely avoided seeking any parties at Belle Plaine who had been hitherto interested in the salt operations there, as I did not wish to prejudice my results for or against any persons or interests.

The examination of the specimens of Red River water made during the summer vacation have been previously reported upon.

The examination of the water from Brainerd has been already reported upon.

*The Belle Plaine Water.*

| | | | | |
|---|---|---|---|---|
| Mineral matter in solution | | 25.10 | grains to gall. | |
| Organic and volatile matter in sulution | | 5.37 | " | " |
| Total solid matter in solution | | 30.47 | " | " |
| Chlorine, Cl | | 3.152 | " | " |
| Silica, $SiO_2$ | | 1.465 | " | " |
| Ferric, aluminic and phosphoric oxide | $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | .068 | " | " |
| Barium sulphate | Ba $SO_4$ | A trace | " | " |
| Sulphuric oxide | $SO_3$ | 1.033 | " | " |
| Lime | CaO | 5.896 | " | " |
| Magnesia | MgO | .544 | " | " |

Alkalies and carbonic oxide ($CO_2$) were not determined.

## *Peat Ashes.*

| Number. | Silica, $SiO_2$. | Carbon. | Iron and Iron Phosphate. $Fe_2O_3$ and $Fe_2P_2O_8$. | Lime, CaO. | Magnesia, MgO. | Sulphuric Acid, $SO_3$. | Undetermined. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| 16 | 51.30 | 1.81 | 9.30 | 10.89 | 6.12 | 5.19 | 15.39 | $CO_2$ and $H_2S$ in large amount. |
| 17 | 83.13 | .86 | 7.99 | 5.44 | 1.75 | .78 | .05 | Alkalies a trace. |
| 18 | 83.35 | .03 | 5.29 | 7.39 | .97 | 2.57 | .40 | Alkalies a trace. |
| 19 | 72.79 | .95 | 9.46 | 5.92 | 6.13 | trace | 6.25 | $CO_2$, small ; $Fe_2P_2O_8$ 5.92. |
| 20 | 80.55 | .75 | 10.23 | 5.61 | .76 | 1.34 | ...... | $CO_2$, trace $P_2O_5$ trace. |
| 21 | 82.71 | 1.19 | 7.41 | 3.18 | trace | 3.70 | 1.81 | $CO_2$, a trace. |
| 22 | 64.37 | .16 | 21.41 | 6.26 | 1.54 | 7.58 | ...... | $P_2O_5$ a trace. |
| 23 | 72.64 | .75 | 15.46 | 5.87 | trace | 5.73 | ...... | $P_2O_5$ a trace. |
| 24 | 68.06 | 1.34 | 8.82 | 5.03 | 4.81 | 6.53 | ...... | $CO_2$ strong ; $P_2O_5$ trace. |
| 25 | 88.28 | 1.32 | 6.34 | .84 | .51 | trace | 2.71 | $CO_2$ very small ; $P_2O_5$ & Alkalies a trace. |
| 26 | 64.27 | 2.80 | 9.75 | 15.75 | 1.77 | 3.69 | 2.57 | $CO_2$ very strong, $P_2O_5$. |
| 27 | 81.99 | 1.14 | 9.39 | 4.84 | .60 | 1.12 | ...... | $P_2O_5$, Alkalies a trace. |
| 28 | 79.24 | .15 | 5.65 | 7.60 | .98 | 2.76 | 3.62 | $CO_2$ strong, Alkalies a trace. |
| 33 | 57.23 | 1.45 | 16.50 | 11.47 | 2.09 | 8.71 | 2.55 | $CO_2$ strong. |
| 34 | 57.35 | 1.48 | 17.09 | 17.84 | trace | 4.79 | 1.45 | $CO_2$ strong. |
| 35 | 55.30 | 5.57 | 11.26 | 19.04 | trace | 3.26 | 5.57 | $CO_2$ strong |
| 36 | 63.71 | 1.60 | 10.50 | 11.83 | 3.98 | 2.70 | 5.60 | $CO_2$ strong. |

| No. | Total Volatile. | Total Combust. | Ash. | Remarks. |
|---|---|---|---|---|
| 33 | 7.97 | 43.34 | 48.69 | Had been dried about three years. |
| 34 | 8.03 | 45.32 | 46.65 | Had been dried about three years. |
| 35 | 13.43 | 70.96 | 15.61 | Had been dried about three years. |
| 39 | 12.37 | 67.14 | 20.49 | Had been dried about three years. |

Nos. 46, 47 and 48 are limestones.* They were examined for the total amount of matter insoluble in hydrochloric acid, water, iron, alumina, phosphate of iron, lime and magnesia in the soluble portion. As there was only a trace of soluble silicate and phosphates the lime and magnesia were calculated as carbonates. No. 47 gave a small per cent of alkalies, not an unusual ingredient of lime stones. Nos. 46 and 48 gave only a trace of alkalies.

*No. 46 was a sample of the common building-stone from Minneapolis—"No. 5" of the section below the University. Report for 1876. p. 149.
No. 47 was a sample of the building-stone from Taylor's quarry, near Fountain, Fillmore county, and was compact and non-argillaceous.
No. 48 was a sample of the impure limestone from Minneapolis, from "No. 1" of the section below the University. Report for 1876, p. 148.—N. H. W.

Analysis gave the following results:

No. 46.

| | | |
|---|---|---|
| Portion insoluble in hydrochloric acid | 14.45 | per cent. |
| Water ($H_2O$) | 1.60 | " |
| Ferric oxide ($Fe_2O_3$), Alumina ($Al_2O_3$) / Ferric phosphate ($Fe_2P_2O_8$) | 1.70 | " |
| Carbonate of Lime ($CaCO_3$) | 75.482 | " |
| Carbonate of Magnesia ($MgCO_3$) | 6.810 | " |
| | 100.043 | " |

Alkalies, sulphuric acid and soloublé silica, of each a trace.

No. 47.

| | | |
|---|---|---|
| Portion insoluble in hydrocloric acid | 9.890 | per cent. |
| Water ($H_2O$) | 0.240 | " |
| Ferric oxide ($Fe_2O_3$), alumina ($Al_2O_3$) / Ferric phosphate ($F_2P_2O_8$) | 1.300 | " |
| Carbonate of Lime ($CaCO_3$) | 86.107 | " |
| Carbonate of Magnesia ($MgCO_3$) | 00.470 | " |
| Alkalies | .440 | " |
| | 99.447 | " |

Sulphuric acid and soluble silica, of each a trace.

No. 48.

| | | |
|---|---|---|
| Portion insoluble in hydrochloric acid | 16.220 | per cent. |
| Water ($H_2O$) | 0.375 | " |
| Ferric oxide ($H_2O$), Alumina )$Al_2O_3$) / Ferric phosphate ($Fe_2P_2O_8$) | 3.075 | " |
| Carbonate of Lime | 54.533 | " |
| Carbonate of Magnesia | 36.002 | " |
| | 100.205 | " |

The magnesia is a fraction of one per cent too high. Alkalies, sulphuric acid and soluble silica, of each a trace.

These results would give these limestones the following values for burning into lime. If completely burned,

100 pounds of No. 46 would give 61 pounds of lime.
" " " " 47 " " 60 " " "
" " " " 48 " " 62 " " "

Of the 61 pounds of No. 46, 45.5 pounds are available for mortar.
" " 60 " " " 47, 49 " " " " "
" " 52 " " " 48, 42.5 " " " " "

The mortar from Nos. 46 and 47 would be nearly a pure lime mortar, that from No. 48 would be one-third a magnesian mortar.

One houndred pounds of pure carbonate of lime will yield fifty-six pounds of lime, after burning, all of which would be available for mortar.

Practical results would vary somewhat from the above as more or less skill was exercised in burning the limestone.

No. 54. Lime Concretions found in the Brick Clay at Minneapolis.

| | | |
|---|---|---|
| Matter insoluble in hydrochloric acid, chiefly $Fe_2O_3$ . | 4.62 | per cent. |
| Calcium Carbonate . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 94.83 | " |
| | 99.45 | " |

There was also a trace of magnesium carbonate and organic matter.

Feb. 25, 1878.

*Report on Serial Nos. 49, 50 and 51, Well Waters from Brainerd.*

| Owner's Name. | Serial Number. | Total Solid Residue. | Mineral Residue. | Organic and Volatile Residue. | Permanent Hardness. | Removable Hardness. | Total Hardness. | Chlorine. | Free Ammonia—Pts in 100,000,000. | Albuminoid Ammonia—Pts in 100,000,000. | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C. H. Alsop... | 49 | 31.287 | 24.283 | 7.004 | 8.172 | 6.421 | 14.593 | 42.728 | 132. | 49. | Sulphuric and Carbonic acids, a trace. |
| Al. White..... | 50 | 16.519 | 13.250 | 3.269 | 6.129 | 3.210 | 9.339 | 4.027 | 0. | 9. | " " |
| Leland House. | 51 | 37.241 | 30.937 | 6.304 | 9.923 | 4.378 | 14.301 | 50.900 | 26. | 13. | " " |

These waters are very unlike. No. 49 is a hard well water, very bad indeed from free and albuminoid ammonia. The latter might be derived from decomposing vegetation, but the free ammonia in such large quantities gives unmistakable proof, in the absence of other causes for its presence, of sewage contamination. No. 49 also contains a very large proportion of chlorine which is also proof of contamination. No. 50 is a pure well water, somewhat hard, but very free from ammonia in any form. The amount of chlorine is also small. No. 51 is harder than No. 49. It contains less ammonia than 49 but still sufficient to indicate contamination, especially when considered with the large amount of chlorine that it contains. All three of these waters contain only a trace of sulphuric acid $SO_3$ and a very little carbonic acid ($CO_2$). In waters containing so much chlorine it is useless to attempt to estimate calcium and magnesium with soap; the method of Parke's does not answer, excepting for those waters containing carbonates as I have stated in a former report.

Nothing in the appearance of these specimens would indicate that there was any difference between them or that they were unlike ordinary well or spring water.

Respectfully submitted,
S. F. PECKHAM.

MINNEAPOLIS, MINN., Dec. 11th, 1877.

P. S.—Dec. 29th. In 49 and 51 the chlorine appears greater in amount than the total solid matter. This chlorine is correct and doubtless exists in some volatile form. There was not water enough for me to ascertain to what cause the discrepancy is due, but the reason assigned above is I think adequate.

S. F. P.

# X.

# ENTOMOLOGY.

## REPORT OF ALLEN WHITMAN.

*Prof. N. H. Winchell, State Geologist:*

SIR:—I have the honor to contribute to The Geological and Natural History Survey of Minnesota the following entomological notes for the year 1877. They refer mostly to the locust, with the disappearance of which we are left once more to contend only with some of the common pests of the garden, and of fruit, shade and forest trees. In this respect we are fortunate that we still lie outside of the range of some of the most pestilential enemies of the grain and corn fields; and although a persistent cultivation of any growth will probably bring in time all the insect enemies of that growth which are capable of existence and reproduction here, we are subject for the present only to the attacks of enemies not numerous in species nor excessive in number when compared with those of longer cultivated and more thickly settled States. These however are troublesome enough and are attracting more and more the attention of our horticultural and agricultural societies, as they have already attracted that of the few gentlemen in the State who have been able to devote to the study of Entomology a portion of the time largely due to other pursuits.

It is hardly the work of the Geological and Natural History Survey to furnish instruction in elementary or economic entomology. Circumstances have made it seem necessary or desirable to collect all possible information on the subject of the locust, particularly that species which has become so well known in this State of late years, in regard to which much is still to be learned, and which is still a kind of fabulous bugbear to those States which are free from it. For the purpose of completing what has already been written in previous reports, the subject is here continued. But that there are other insects in regard to whose habits, together with the best means of protection from them, our farmers and gardeners could be profitably instructed, is shown by

the attention which has been paid to the subject during the past year at the meetings of our horticultural and agricultural societies, and by the (unsuccessful) attempt made in the last legislature to obtain a meagre appropriation for the purpose of issuing a pamphlet to meet the supposed need of it. It is too often the case that the inability to provide against injuries results from a lack of that knowledge of the growth and transformation of insects that ought to be in the possession of even the children in our common schools; while many pests which are practically known to every gardener while in their destructive stage, are wholly unknown to him in those stages when they are preparing to commit future injury. The State Entomologists of Missouri and Illinois (and perhaps other States,) have considered it worth their while to preface their earlier reports with brief manuals of elementary entomology. A small pamphlet of this kind with brief notices of the form, growth and habits of some of our most common species of injurious insects might be issued by the Agricultural Department of the State University (as has been done at the Agricultural College of Michigan,) and would render great service. In addition to this every one who is interested in the matter may contribute by sending to the Museum of Natural History at the State University, specimens of every kind of destructive insect, in all forms or stages of it that are capable of preservation. A collection formed in this way would in time become of great practical value, and at the meetings of the horticultural and agricultural societies at Minneapolis, would become available to a large number of persons.

Not to go outside of our cities, a large percentage of the yearly injury or ruin to our shade trees, is occasioned or increased by insects, while oftentimes the owners entertain no suspicion of the cause of the evil. We set out maples again and again, to be seriously damaged by the havoc of boring-beetles or of the Maple Aegerian, while the box-elders are defoliated and rendered unsightly by the caterpiller of an insignificant yellow moth.

Outside of the cities, in addition to the damage inflicted by the locust, the Colorado Potato Beetle has done perhaps more injury than in any year since 1870, while certain blister-beetles and the potato-stalk weevil have been more noticeable than before. While this is in writing the report of the Hon. T. M. Metcalf, Commissioner of Statistics, for the year 1877, states that the Chinch Bug has committed considerable injury in Houston county during the year. As this is an enemy to a considerable extent unknown to our farmers, I add a few brief notes in regard to it, with the hope that they may be of some value, if the evil makes its appearance again this year.

Another insect which has appeared in far greater numbers than usual during the year is the Tent Caterpillar of the Forest, (Clisiocampa Silvatica. Harris.) [Vid. Harris' Report p. 375 and Riley's Third Annual Report of the State of Missouri.] These were abundant about Brainerd, as is shown by the following :

BRAINERD, MINN., July 6th, 1877.

DEAR SIR :—I send you by express a few specimens of the army worm. East of this place they are very abundant, and the northern limit of this caterpillar is unknown. They have been observed one hundred and fifty miles north of us (by the Mississippi river) on that stream.

They eat the oak and bass wood only. In the vicinity of Island Lake on the line of the N. P. Railway, they have been very plenty, but are decreasing, advancing southward.

Yours most truly,
J. C. ROSSER.

The following extract probably refers to the same insect:

"The caterpillars have again made their appearance in large numbers in the timber in the vicinity of Eagle Lake, and are eating the foliage of the trees, in many instances almost stripping them bare. Last year they occupied the same district, covering a district from four to six miles in extent. This year they are more numerous, and we suppose are gradually extending their operations."—*Mankato Review, June 12th, 1877.*

The works referred to above describe this insect very fully, and give the means of preventing its increase.

THE ROCKY MOUNTAIN LOCUST.

The area of the egg deposits for the year 1876 will be found on the "Map of Locust Areas," in the report of the Geological and Natural History survey of that year. The statements upon which this was based came from over six hundred townships in about forty counties. The reports as to the density of these deposits varied greatly in the different counties. It was generally thought that there were very few or no eggs along the Dakota line, and in most of the territory where the young had hatched in 1876 ; that they were more numerous along the eastern line of the egg-area, where however but comparatively few appeared in the Spring ; and more numerous still in a strip of country reaching southeastward from Otter Tail to Blue Earth and including those counties, and in fact it was in this strip of territory out of all the locust region from Minnesota to Texas, that the greatest damage of the year 1877 occurred. The eggs were also thickly laid in the southern range of counties from Rock to Freeborn as well as in nearly every county in Iowa lying south of these, but all this portion of the locust region, both in Minnesota and Iowa, escaped with far less damage than had been expected, and in nearly every case with the best crops known for years.

PROGRESS DURING THE SPRING.

The locust events of the spring and summer were a succession of hopes and disappointments, ending finally in a large measure of unexpected success. The warm weather of February, followed by severe cold in March, seemed to exert in most cases no appreciable effect upon the vitality of the eggs. It was forgotten that the weather reports of March and April for the past four years would

show that the eggs are almost every year subjected to more or less freezing and thawing. When the hatching time came the young failed, for various causes, to appear in large numbers, in many places where the eggs had been laid at least as thickly as in previous years; but on the other hand they came forth in such overwhelming numbers in other places, that the unequal conditions of the different parts of the locust area, added to all the uncertainties of what the next few weeks would bring, rendered the loosely drawn and self-contradicting bounty law* of 1876 an obvious failure, and no steps were ever taken to carry it into effect. The prospect during the last ten days of May was disheartening. In thirteen counties, in parts of some and in nearly the whole of others, clean sweeping destruction of wheat and serious injury to many other crops were already in progress, while in about twenty other counties the young had appeared in sufficient numbers to cause great apprehension. From the first of June onward there was marked improvement; where the locusts were excessively numerous and where the wheat had been trimmed to the ground at that date, the crops failed to recover; but where the growth still remained or had not been badly eaten, the comparative amount of injury grew less from day to day until the crops for the most part were safe except from migrating swarms. Then followed a series of migrations in July and August, which though they added a little to the territory already injured, were so different from those of other years as to be mainly harmless. The result of all this was far different from anything which could have been expected in May, and the returns of the Commissioner of Statistics for 1878 will probably show that the locusts destroyed more bushels of grain in 1877 than have been

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GENERAL LAWS OF MINNESOTA FOR 1877; CHAPTER 86.—The act appropriates $100,000 for the destruction of grasshoppers and their eggs. The bounty is to be paid only to persons living within counties affected by grasshoppers. The sums to be paid are as follows: fifty cents per gallon for eggs; one dollar per bushel for grasshoppers caught previous to the 25th of May; fifty cents per bushel from the 25th of May to the 10th of June; twenty-five cents per bushel from the 10th of June to the 1st of July, and twenty cents per bushel from the 1st of July to the 1st of October. Instead of "caught" it would be better to use the word "delivered," for obvious reasons.

Other sections provide for the delivery of captured grasshoppers to measurers appointed (by the Governor) for each township, and for payment of bounty through certificates issued by county auditors, audited by boards of county commissioners, filed with the State Auditor, and paid with his warrant upon the State Treasurer. Although the provisions of the act extend to October 1st, the money appropriated by the act can be applied only to the payment of certificates filed with the State Auditor on or before July 15th. If the amount of these certificates exceeds $100,000 they are to be paid by the State pro rata to the amount of $100,000, and the balance in full paid by the counties according to the amounts due on certificates issued by each county. Furthermore; "no other or greater amount than $100,000 shall ever be paid under the provisions of this act."

It is entirely an unfair proportion between the price to be paid up to May 25th (one dollar per bushel, which is none too much) and from June 10th to July 1st, (25 cents per bushel,) when the locusts are in the pupa or winged state, and may easily be caught by the barrel, after nightfall. One farmer estimated the amount caught by him at this period at 400 bushels; another at 800 bushels. Besides this, it was obvious before May ended that a few of the worst infested counties would easily exhaust nearly the whole appropriation, perhaps without saving any great amount of crops; while others (which finally escaped almost unharmed without any use of the bounty law,) would have to be responsible for nearly the whole of its bounty certificates.

Other sections provide for one day's labor per week of all males between twenty-one and sixty, in the several townships of the afflicted counties, for five weeks after the grasshoppers become large enough to be caught easily; such labor to be performed under the direction of overseers of highways, who are to give notice of the time and place where it is required.

This is liable to call a man away from the defence of his own field at the very time when he is most needed at home. The same amount of labor, assessed *before the grasshoppers hatch*, in destroying eggs, or in ditching to prevent incursions, would prove far more effective.

destroyed in any other year, and that the amount left to harvest fully equalled any annual crop yet produced.

The causes of this unexpected result are for the most part a series of favorable climatic conditions. As in the year 1876 the returns of locust damage inflicted mostly in July and August, included a considerable diminution of the wheat crop by drouth in June, so, on the other hand, counties harvesting a full average crop in 1877 will probably report no damage, even where the crop was really somewhat reduced by the locusts. For once, the farmer, taking the annual chances of rain, hail, blight, drouth, insects and other destructive agencies to which he is from time to time subjected, has found the influences of climate to be so largely in his favor as to offset what otherwise promised to be an unmitigated evil, and if it is not probable that the state will be often overrun by locusts in any series of years, it is still less likely that in any one "locust-year" the hatching will again be reduced to a nullity through so large a portion of the egg-area. But that events of this kind do actually repeat themselves in the long run, is shown by the fact that the locust events of 1857 (so far as they can be recalled) are almost exactly repeated in 1877, in the thick deposit of eggs, in the character of the spring weather, in the damage which proved less than anyone had expected, and in the final departure of the migrating swarms in July and August to some unknown destination from which they failed to emerge in great numbers for several years. Of course all that is here stated of the successful results of the harvest of 1877 is said with a full knowledge of the sweeping destruction in some of the worst ravaged counties, but also with a consideration of all those counties where the locusts failed to inflict injury, and where it would have surely followed in a spring resembling that of 1876.

Other and less considerable causes tended to reduce the expected percentage of injury. These were, a certain but hardly calculable amount of destruction of the eggs by insect and other enemies, and a partial failure of the eggs to hatch, "from causes unknown;" a comparatively trifling destruction of the young by snow storms at the end of April; and, more efficient wherever applied, the destruction of the eggs by plowing and harrowing the egg-beds during the fall and spring, and the destruction of the young with ditches, tar-pans, nets, and other contrivances. To this must be added that in some cases where the young were fully as numerous as in other years they were far more harmless, and also that eggs deposited in September and October, 1876, were hatched so late that the crops were mostly beyond the reach of the young.

## HATCHING.

The cases of reported hatching in February were, so far as ascertained, entirely the appearance of native species. All of those sent me were of a size that generally precluded the possibiltty of their having hatched in February. Three of our common native species were received, of which two became winged in the first week of March, but neither of the same species was observed in the fields until the 25th of May. The young (perhaps of Spretus) were seen

in our southern counties by the 10th of April, and by the 20th of the month had appeared in considerable numbers along the river bluffs between St. Peter and New Ulm. Part of these, and perhaps all, were destroyed by a storm which came about a week later, but they were only a trifling portion of all that were to appear. Innumerable newspaper items, letters, and replies to circulars show that it was not until the first ten days of May that the eggs hatched in greatest numbers, with slight difference between the dates of appearance in the northern and southern counties.

### LATE HATCHING.

It was noticed everywhere that the hatching of 1877 was more prolonged than usual. This was in part due to the dampness of the spring, but more to the fact that eggs had continued to be deposited much later than usual in the fall of 1876. A case reported in 1875, when a single swarm alighted (at Waterford, Dakota Co.,) on the 18th of October and deposited eggs which did not hatch until the 20th of the following June, gives an opportunity of observing how much the late deposits are behind the early ones in the time required for hatching. Eggs left late in the season in this way wintered over in a fluid condition, which often created an impression that they were rotten, but I had no difficulty in hatching such with a three weeks' warm exposure. These finally hatched in the fields, but in most cases too late to do much injury. Their final exodus from the hatching grounds was also two to three weeks later than elsewhere, and on the 8th of July, when the locusts had all acquired wings, and had entirely left the neighborhood of Glencoe, I found, a few miles farther west in Renville county, the young in about the same stage of advancement that I had seen around Mankato on the 21st of June, from one-third to two-thirds still in the pupa-stage. But in general, where injury was severe, it was only in places where the young had been numerous as early as the last week of May, and it is only in an excessively dry year, with a slender growth of grain, that the crops are likely to be badly injured by the young that hatch after the first of June.

### FAILURE IN HATCHING.

Throughout a large number of counties, and perhaps throughout the whole egg-area, a certain percentage of the eggs failed to hatch. In limited areas the failure was so great as to amount to almost complete exemption from injury. It is difficult to calculate what percentage of the eggs thus failed, but there is no doubt that it was often a large one. It is the opinion of those in Nobles county who have interested themselves in observing such matters, that eggs have never been laid so thickly in that county as in 1876, but hardly a wheat field was destroyed by the young in 1877. While this is in writing I have received brief reports from nearly every locust county in Iowa. There as in Minnesota, the hatching was in many cases far less numerous than

the extent of the egg-deposit had led people to apprehend, and in others the injury resulting from the great number which did hatch was much less than usual. The result is condensed by Prof. C. E. Bessey, of Ames, as follows: "In the fall of 1876 they (the locusts) laid many eggs in Central Iowa. In the spring of 1877 they hatched, but for some reason, not known to me, (nor any one else hereabouts,) they did not amount to much."

The causes of failure in hatching are generally stated to be "unknown." They are no doubt the unusual temperature and rainfall of the spring and the action of the Silky Mite and various grubs. It is precisely in those counties of Minnesota and Iowa where the locust evil has been most permanent for the last five years that the eggs have been apparently destroyed, while the territory of densest hatching and most sweeping destruction in Minnesota lies almost entirely outside of what has been the region of greatest and most continuous damage for the last five years. As the persistent cultivation of any growth is followed by a corresponding increase of its insect-enemies, so the increase of these insects is followed by multiplication of the parasites and enemies which prey upon them. The destroyers of the locust eggs, not endowed with the same efficient powers of locomotion as the locust itself, are confined to a smaller range and continue to multiply within it. and where the locust deposits eggs for a series of years within the same range, its enemies will in time multiply, rarely perhaps in sufficient numbers to overpower the locust, but sufficiently, when aided by other favorable conditions, to produce a marked diminution of the species; while to preserve the balance still further the locust carries its own enemies with itself to other laying-grounds not only in the germ of the slowly moving locust mite but of the swift Tachina Fly.

## AREA OF GREATEST INJURY.

The greatest injury inflicted by the young during the spring, and in fact the area of all injury in the State worth reporting, was confined to a strip of country extending southeastward from about the centre of Otter Tail county to Lake Crystal, and lying along the edge of the timbered regions. On the east it was partly bounded by the timber, extending some little distance eastward into it in its northern part, (into Todd and Stearns counties), the hatching growing less as it progressed eastward, and finally failing almost entirely, except in open spots along the Mississippi. On the west the boundary was irregular. It was limited mostly by the line of what had been the most frequent cultivation in 1876, confined to river valleys and the points of thickest settlement, while as the farms became more scattered, (to the westward) the hatching thinned out, and finally ended almost entirely where stretches of unbroken prairie began. In general the swarms seemed to have progressed eastward (in Minnesota) in 1876 without halting to lay except in the vicinity of cultivation, and to have been checked in their progress by the timber and to have massed their forces along its edge. At any rate this region was a laying ground through the whole of the preceding season from the middle of July, through August and

sometimes into September. It is difficult to convey, to one who has not seen such sights, an idea of the immense numbers of the young that appeared in some parts of this infested region in the last week of May. The wheat fields covered with the young, and sometimes trimmed bare of every green blade, the low bushes by the roadside stripped of their leaves, the young locusts dancing into the air, and flickering like heat in the sunlight before the horses' feet in a ride of miles across the prairies, the road-beds blackened with the young basking on the warm sand, all these, which had then hardly begun their devastating marches, prophesied the injury which was destined to ensue. These were extreme cases, but elsewhere, where the numbers were less, the bands which came marching over the fields, one after another, finally sufficed to make way with nearly every crop within their reach. Later on, the wheat which had been left by the young in May was trimmed of its green leaves, and the stalks were left like spindles, blackening in the sun, while the locusts having destroyed about every crop (except oats) which happened to lie in their path, trimmed out the tender portions of the prairie grass and made it almost unserviceable for grazing. The oats, the foliage of which was hardly touched, were attacked while heading out, and the slender stems of the berry cut off, but generally something of an oat crop was harvested when there was hardly anything else left to gather.

A general, but hardly an organized warfare was waged against the young almost from the outset, every man defending his own fields as best he could. In the nineteen counties which the Hon. Commissioner of Statistics reports as more or less injured, the acreage of wheat was less by 113,700 acres than in the preceding year, but was still considerable, amounting to 337,000 acres. Of these counties eight showed an increase of wheat-acreage over 1876, while, of the remaining eleven, four counties sowed from three to six-sevenths less than in the preceding year. There were instances of men who, warned by former experience, sowed nothing whatever, as well as of men who sowed as largely as though no enemy were at hand; but far the larger majority were the cases of those whose only hope of a decent subsistence depended on such a crop as they might bring through to harvest. The energy with which most of these began the battle as soon as the young made their appearance, was worthy of all success. The usual methods of burning the young were resorted to at once, and in some cases ditches were run about the fields. Towards the end of May the coal-tar pan, which had been used in various forms in Kansas, Colorado, and elsewhere, came at last (after having been fully described during the preceding year,*)

*There was no reason why the use of coal tar, kerosene, &c., in pans or otherwise should have seemed a novel or providential invention to the people of Minnesota. The use of tar spread upon building paper was fully described in the Report of the Geological and Natural History Survey of Minnesota for 1876; a full description of the kerosene pan was sent broadcast in one of the "patent insides" of our country papers for the same year; a letter from Greeley, Colorado, dated August 5th, 1876, to the Farmers Union of Minneapolis, describes the use of coal-tar spread upon canvas, to be dragged over the grain; while in the proceedings of the Grasshopper Convention at Omaha, (page 51) the same instrument was described again. In spite of all this the use of coal-tar seemed absolutely unknown to the people of Minnesota until it was make known to them by the letters of the Hon. A. B. Robbins, of Wilmar, to the St. Paul Pioneer Press in May, 1877.

to the attention of the people of Minnesota, and was seized eagerly as an instrument that promised to be effective. For the next three or four weeks, wherever tar and sheet-iron could be obtained, men, women and children dragged the tarpan industriously over the grain fields, until the instrument became either useless or unnecessary. By the middle of June the locusts had grown so large that other means of catching had to be devised, while in the majority of cases the crops were either so badly injured as to be not worth fighting for, or were so far beyond the reach of the locusts that remained that further fighting was unnecessary. It is difficult to estimate the exact amount of success to be attributed to the different methods of destruction as they were applied, or indeed to any method that has been applied so far. In a warfare of this kind the farmer must take his chances, and what proves successful in one place, or in one year, may be totally futile at another time or place. In spite of all that has been said and written for the last three years it is necessary to say here once more what most of our farmers are at last convinced of, that in strong emergencies there is no dependence to be placed upon anything but a well dug and carefully tended ditch about the fields. If properly constructed it will prove, in nine cases out of ten, an absolute barrier until the locusts acquire wings, when the element of chance comes in again. Dr. J. C. Currier, of Mankato, managed with a ditch to save entirely unharmed the crop of 160 acres, in the midst of locusts hatching out in unusual numbers, and the method, the cost, and the result of the experiment will be found in full in the report of the National Entomological Commission; upon the Barden farm near Windom it is reported that a heavy crop was saved by a diligent use of tar-pans; Mr. Robert Lowe, of Lynn township, McLeod county, in a neighborhood where the locusts hatched in great numbers, managed to save part of a crop by using the tar-pan early in the season, and later on an open-mouthed trough, dragged over the grain after nightfall. Under the date of Nov. 21st, 1877, he writes:

> "The field of wheat opposite my house yielded me 20 bushels to the acre,—the part of it which I saved, which was about 10 acres. The two neighbors of mine north of me did not fight the hoppers at all, and that part of the field next to them was eaten close. I kept working at them every night, but they got a part of it before they left.
>
> On a three-acre field south of my house, the hoppers ate about one acre of it; they came from another neighbor that did not fight them. The two acres left yielded me 25 bushels to the acre.
>
> The two neighbors north of me, above referred to, had about 25 acres of wheat each; one of them harvested 4 bushels to the acre, the other $3\frac{1}{2}$ bushels.
>
> I had 20 acres of new land and 5 acres of old land in wheat in another place. None of the neighbors around fought them and I did not get a kernel off that. The hoppers were more than I could handle there and on that I *did* save, so I confined my operations to that I saved. One neighbor near me who *did* fight the hoppers, saved 65 bushels from about 7 acres."

On the other hand there were fields that were swept clean of grain at the very outset. The only thing that could have saved such would have been a ditch constructed before the locusts began their march. To say that such a ditch would have proved insurmountable in every case would be to assume too much, but there is no question that it would have succeeded in a large number of cases where every other defence failed.

All this refers to protection against insects hatched outside of tne grain fields. There are also large extents of wheat sown upon newly broken prairie ("new-breaking,") where the eggs had been deposited in great abundance in 1876. Wherever the deposits had been left undisturbed, the growing wheat was destroyed at the outset. Even where the surface had been harrowed or broken with the seeder in the fall of 1876, the eggs left undestroyed were still numerous enough to consume the wheat as fast as it grew. Only plowing the eggs under deeply, or vigorous harrowing of the surface in the fall or spring, with the use of a tar-pan pan to catch such as hatched upon the field, together with a ditch to prevent incursions from without, might have sufficed to save such fields as these.

### INJURY TO THE CROPS.

Nineteen counties are stated by the Honorable Commissioner of Statistics to have been more or less injured in 1877. These are as follows: Kandiyohi, Chippewa, Wright, Stearns, Nicollet, Pope, Douglas, Swift, Otter Tail, Stevens, Grant, Todd, Renville, Sibley. McLeod, Meeker, Yellow Medicine, Brown, Redwood. He adds: "The most careful estimates of the bushels harvested by the counties gives the following results:

Kandiyohi and Chippewa, total loss; Wright county, slightly injured; eight counties are believed to have saved half a crop; one, a third; one, a tenth; two, two-thirds; three, three-quarters; and one, four-fifths.

This was the Commissioner's estimate in October, and it is not probable that exact statistics will *add* anything to the estimated loss. Of the above counties three were probably more injured by the flying swarms than by the young. In addition to the counties named above, thirteen others were by the end of May in a state of more or less apprehension, and tar-pans were put to vigorous use. A hot, dry June like that of 1876 would have resulted not only in greater damage in the injured counties but would have added many other counties to the injured area.

The comparative temperature and rainfall for the last four years may be seen from the following table, derived from the reports of the Signal Service at St. Paul.

| | Average Temperature. | | Total Rain Fall in inches. | | Number of days when rain fell. | |
|---|---|---|---|---|---|---|
| | May. | June. | May. | June. | May. | June. |
| 1874 | 62.24 | 68.7 | 1.65 | 11.67 | 7 | 16 |
| 1875 | 58.81 | 63.6 | 3.06 | 4.33 | 12 | 17 |
| 1876 | 59.2 | 66.3 | 3.15 | 2.02 | 12 | 14 |
| 1877 | 62 | 63.7 | 5.43 | 7.13 | 12 | 13 |

The total rain-fall in May was considerably greater than in any of the three preceding years, while that of June was greater than for any year since 1874. The average temperatures for May and June do not differ greatly from other years, but a detailed table would show the result of weather much better than a table of averages. It would show a well distributed rain-fall, accompanied by cold days, with northeast winds. This was the character of nearly all the former half of June. The result of this in May was a more than usually prolonged hatching, as the rain coming just when the egg-pods were bursting arrested the hatching for a time, and no doubt prevented it altogether in soils that retained moisture. Eggs thus arrested were found in the latter part of May in a decayed condition, and a prey to the Anthomyia maggot. The last two weeks of May however were warm and dry, and this gave the young insects a full opportunity for destroying the grain where they were numerous. But the change of temperature early in June again arrested their progress wherever the grain had not already been badly cut off. The large number of damp, cold, and cloudy days deterred the locusts from eating, and gave the grain an opportunity to recover itself, while the temperature was exactly such as to produce the strongest and rankest growth of wheat foliage. As this sprang up apace and covered the ground, the locusts, loving warmth and sunlight could not spread through and over the fields as in a year of slender and sparse growth, while the abundance to be eaten necessarily left more which escaped untouched. In many cases the wheat in this way attained a growth which afterwards remained beyond the reach of the locust. In others the insects were abundant enough to trim off the foliage, and in the first week of July thousands of acres of wheat stood in the fields like bare spindles, the head still enclosed in the terminal leaves. Possibly a continuance of favorable weather through July would have produced something from even such fields as this, but, in the hot, dry weather which followed, the heads never filled.

But it is to favorable temperature more than all else that we are to assign not only the abundant harvest in the uninjured counties but such crops as were saved in the remainder. Those who believe that the efficacy of our prayers may be tested by the material results which follow them, can safely find a beneficent answer to the fasting and supplication of April, not in a brief snow storm that perhaps destroyed an insignificant number of locusts which would in all probability have proved harmless, but in a whole season of favoring winds and nourishing rains.

The effects of climate were seen too upon the young insects as well as upon the grain. It is to this doubtless that we are to assign the cause of the often reported disappearance of the young in the spring without committing injury, and of the harmlessness, "from causes unknown," of such as remained up to the time of flying; reports which come from Iowa oftener than from Minnesota. It is to the same cause no doubt that we are to attribute the number of locusts found dead in the fields during the spring; numbers which were very inconsiderable when compared with those which remained alive, but sufficient to show that unusual agencies were at

work. To those who from limited observation believe that the species is proof against moisture, it may be asserted that a spring of a different character from the four preceding has been followed by an unusual series of locust events, viz.: comparative harmlesness of the hatching brood, a partial degeneration, and finally a total migration as if from an unnatural neighborhood; while still others are to be reminded that the State is no more a permanent breeding ground of the species, and no more likely to be, than it was some years ago.

### MOVEMENTS OF THE WINGED.

Here and there a fully winged individual of Spretus may be found in our fields early in June. I noticed such on the 8th of June, 1876, and on the 14th day of June, 1877, while others were reported as early as the 26th of May. From the middle of June the number of the winged increases rapidly, and these often rise in the air singly, and float lazily along on the breeze. On the 19th of June I observed such at Mankato, as thick in the air as stars upon a moderately starry night, while upon the ground below a still greater number had developed wings, and on being disturbed would start up for a low flight of a rod or two. Here and there one would rise from the earth, and could be seen rising very gradually in the air for a long distance, until it finally became lost to sight. Neither on the ground nor in the air was there any appearance of swarming. The numbers in the air increased rapidly from day to day until the last week in June, when, as if they had begun to mass their forces, dense swarms could be seen moving slowly, high in the air, over the central portion of the State. These, though appearing to move southeast on the 26th, 27th, and 28th of June, were not seen east of what had been the hatching area. From the latter date until nearly the middle of August the State was repeatedly crossed and recrossed by immense bodies of locusts, alighting heavily and destructively in the first week of July, but only appearing high in the air, and purely as migrating swarms later on. These movements consisted generally of bodies, (rather than of one immense swarm,) seen here and there over a large area, all pursuing one general direction, and following each other for a few days until the supply seemed exhausted, when, after a change of wind, what were apparently parts of the same army, returned over their former track only to be carried back again with others when the wind changed back again. As the season advanced, the swarms making up these armies became more scattered, and followed each other at wider intervals, or were soon separated at long distances from each other.

### MIGRATIONS.

These movements may be briefly summed up as follows:

July 3d–7th—A movement to the northwest by daily journeys, with heavy alighting each evening from Willmar westward to the Sisseton Reservation and beyond.

July 8th-10th—A change of wind, with a return at once to the southeast. This movement was observed at sixty points between Bramble county, D. T., and Freeborn county on the south, and between Otter Tail and Sherburne counties on the north.

July 11th and 12th—A change of wind and return of the swarms to the northwest, observed at various places between Detroit and Sioux City on the west and between Sioux City and Fort Randall, D. T.

July 20th and 21st—An immense movement to the southeast again, observed at 78 points in Minnesota and Dakota. Swarms were seen on the western line of observation, at various points between Walhalla and Rockport, D. T., 375 miles from north to south, and between Rockport and Albert Lea, on the southern line, 225 miles from east to west.

July 28—Another movement to the southeast, seen over various northern and southern counties, but not reported over a large number of intermediate points.

August 1st and 2d—Another extensive movement to the southeast. This was seen at various points between Glyndon and Luverne on the west, and at St. Cloud, Anoka, Northfield and LeRoy on the east.

Aug. 6th-9th—Heavy flights, (but decreasing in numbers daily) to the southeast again; seen mostly on a line between Benson and Mankato and Worthington.

Sept. 2d—"Large numbers" flying southeast over Waseca.

Sept. 18th—"Millions seen flying in a southeasterly direction" at Long Prairie.

There is reason to believe that, as has been known elsewhere, many of these swarms continued their flights through the night. They were observed on several occasions flying till nearly sundown, while it was impossible to learn of their alighting anywhere at or during the night; they were seen moving early in the morning as soon as the sun was high enough to make their numbers visible, while there was no known starting place from which such swarms could have proceded so early in the morning; and in one known case, (and probably in many others,) they abandoned in the night a spot where they had been abundant during the day.

It will be noticed that after the 20th of July all extensive movements were to the southward. On the dates intermediate between those given, there was a change of wind to southward, and this carried back sometimes considerable, but always scattered bodies to the northwest, while as the season advanced the number thus carried back became fewer. Those which were carried to the northwest probably helped to make up the bodies which moved southeast again as soon as the wind changed to northerly, and what may have been something like a compact army early in July were spread over a large territory later on. The change of wind between the 7th and 8th, and again between the 10th and 11th of July were followed at once by the return of swarms over the track where they had passed the day before; on the other hand it required a change of wind from the 12th to the 20th and again from the 20th to the 28th

of July to collect and bring back the swarms which passed over on the latter dates. During the later movements too, straggling bands were seen at a considerable distance to the east of the main bodies, as at St. Paul on the 20th of July, on the 1st and 2d of August at Anoka, St. Paul, Northfield and Leroy, on the 6th of August at Hastings, Dundas, and Brownsdale; and during August and September over El Paso, Wisconsin, and over Osage, Grundy Centre, Toledo, and Montezuma, aud perhaps over Waverly, Waterloo, Oskaloosa, and Vinton, Iowa, all of which points lie considerably to the east of the usual locust area.

All the movements after the 10th of July were purely migrations. Here and there individuals dropped down from the passing swarms until a township or two was pretty well covered, but as a rule the insects passed over without alighting. To determine the migratory capabilities and habits of the locust would be interesting and useful. During the summer I collected nearly a thousand reports, diaries, &c., to learn the extent of the flights over Minnesota. The impossibility of obtaining similar reports from Central Dakota, and the absence of such from Iowa, render it difficult to trace movements beyond the State line. The turning point of flights between the 7th and 8th of July was evidently in the neighborhood of the Sisseton Reservation; between the 10th and 11th, either in or over Iowa; about the 22d of the month the swarms collected in Dakota along the route between Bismarck and the Black Hills and these were perhaps brought southeast again on the 28th of July.

It seems probable that most of the swarms seen passed to the southward of Minnesota and remained there. It is certain that the bodies composing the different migrating armies became widely separated from each other during the season, and it is highly probable that the individuals composing these bodies were distributed over a large extent of territory and often so sparsely as to remain almost unnoticed. By the first of September the species was found at Sioux City and Fort Dodge, Iowa, in small numbers, but more numerous than the native species; still more numerous at Ackley, where they were preparing to lay; again in very small numbers at two or three stopping places along the road between Ackley and Lyle, at Lyle and at Austin; and a few days later at Lake Phalen, five miles northeast of St. Paul. It is very likely that a careful search in 1878 by those acquainted with the species will disclose the presence of the young in very small numbers at various places in Eastern Minnesota, in Wisconsin east of Hastings, and in Eastern Iowa.

The locust evil being ended for the present, all further consideration of the matter produces in the mind of the farmer only that disgust which is excited by an unpleasant subject. But the time will come again when the possibility or likelihood of locust invasions, and whether they can be anticipated or prevented will be questions of immediate interest. But to a community looking forward to years of prosperous wheat-raising, and knowing that future success depends in some measure upon exemption from various insect plagues, it should seem foolish to conclude the inquiry with that amount of knowledge which has so far been obtained. The National Entomological Commission should be enabled to

pursue its investigations beyond the field where circumstances have so far confined them, into the region where the nature of the locust problem is still largely unknown, and where alone the possibilities and probabilities of future destructive incursions are to be calculated.

## DISTRIBUTION.

A history of former locust invasions, and a full chronology of locust appearances in past years, whether seen in small or in great numbers, in destructive onslaughts upon the grain, or in harmless migrations to other neighborhoods, become valuable to assist in determining what are the regions of perpetual, frequent, or occasional presence. It has been common to call "locust years" only those years in which swarms have appeared in destructive numbers, and to call "locust regions" and "grasshopper counties" those only where cultivation has been sufficient to invite injury. It has often been difficult to collect such facts as there are, and the desire to appear well in immigration statistics induces men to withhold occurrences that would seem to convert their particular localities into "grasshopper regions" for the time being, but which were after all only trifling appearances of a misfortune that was felt elsewhere in full force. "Locust regions" are not created by simple statements of facts, nor are the gardens of the world depopulated by occasional locust invasions.

But a locust chronology for the past fifteen years contradicts the notion that there is anything like periodicity in the appearance of the species, though there are evidently years or periods of excessive multiplication; it also disposes of such vagaries as that the stock has been advancing eastward yearly, occupying a certain belt of country each year; or that they "move mostly in a great circle, touching Missouri on the east, and New Mexico on the south, the Pacific on the west, and far into the British Possessions on the north," the time required for swinging around this circle "being about ten years, though some get behind by being hatched out late!" It has been a locust year somewhere or other nearly every year for the last fifteen years, and swarms have repeatedly swept southward from British America perhaps to Texas, while their offspring moved back northward over the same track in the following spring. It would seem that east of what may be the permanent breeding grounds of the species, there is a region where swarms appear nearly every year, and that the permanence or frequency of appearance diminishes as we move eastward. To say that this region of frequent appearance is not a "grasshopper country," is to say for the present that it is mostly uncultivated and uninhabited, though there is no reason to believe that if it were under full cultivation that it would suffer devastation every year.

This region of frequent appearance reaches eastward nearly to Minnesota, and the frequency results from the fact that the region referred to lies in the track of swarms moving northwestward towards the mountains in the spring, southeastward from the mountains in the summer, and at the same time in the vicinity of swarms occasionally hatched upon the plains. At least it is certain

that the locust has been seen either along or east of the western border of Minnesota nearly every year since 1863. At Walhalla, a few miles west of Pembina, they are said to have come one year and left in the year following ever since in the year just named; in the same year (1863,) they were about Moorhead, around the Coteau des Prairie, Ft. Abercrombie, and were seen flying as far east as the Pomme de Terre River; in 1864 the young hatched near Moorhead, and possibly in other places in the western part of the State north of the Minnesota river; while in July winged swarms from the west made their way in a narrow column up the Mississippi Valley to Le Sueur and Henderson; in 1865 the young of these were troublesome in the regions just named; in 1866, a year of serious invasion in States to the southward, there were but slight and transient appearances of swarms in Minnesota, about Moorhead, and in Redwood and Kandiyohi counties; in 1867, a year in which Iowa was overrun almost as extensively as in 1876, there was no appearance in Minnesota so far as can be ascertained; in 1868 large swarms passed northward over Jackson county for two or three days, probably those which had hatched in Iowa and the States below; in 1869 the insects were seen about Moorhead again; in 1870 about Moorhead and in Brooking Co., D. T.; in 1871 a large number of our northwestern counties were visited, but were injured only here and there; in 1872 the offspring of these augmented by others hatched in Dakota seemed to have passed southward in immense armies over Southeastern Dakota and Nebraska; the events since 1872 are too well known to need repeating.

There is nothing alarming in these statements; it is known well enough in how few of all these years the insects have poured into the State in immense swarms, and how few of all the swarms that have appeared have remained to prove destructive. It is only in a year of excessive and repeated visitation that the small numbers remaining behind from each passing cloud finally become numerous enough in the aggregate to make their presence destructive in the year following. It is only meant to show that Eastern Dakota lies in or near a region where the locust frequently appears; somewhere within yearly reaching distance of the transient or permanent breeding grounds of the locusts. On the other hand but a few miles to the east lies a region where the locust appears but rarely, while still a short distance beyond is a region where it never appears.

A line drawn from Crookston to Le Sueur, thence southward across Iowa through Fort Dodge marks nearly the general eastern limit of serious injury. In Minnesota this is nearly the dividing line between the prairie and the timber, which in Douglas and Otter Tail counties extends some thirty miles to the west of the line though not densely everywhere. From Le Sueur southward the line again coincides very nearly with the western boundary of the Big Woods, until the latter, thinning out give place to the prairie counties of Southern Minnesota and Iowa, where as the physical barriers of the forest no longer exists, the line must represent nearly the natural limits of the encroachment of the species. That there is some such natural eastern limit, coinciding nearly with the line

given, is seen from the fact that the hatching swarms, on migrating, have on no occasion whatever occupied new ground to the eastward, or pursued any line of flight which would not carry them somewhere to the west of where they hatched. Whenever invasions have been carried to the east of the usual line, it has been in all cases by swarms appearing from the northwest, generally late in the season and by slow advance.

These in exceptional cases have occasioned injury or have deposited eggs in the openings to the east of the limits named, but with serious results only in 1856 in the Upper Mississippi Valley, and in Todd and Stearns counties in 1876.

To determine exactly how far east the species has hatched of late years, and to say just where it definitely ended, would have required careful examination by those acquainted with the species. It hatched in 1877 in observable numbers at least fully up to the line given upon the "Map of Locust Areas," in the report of the Geological and Natural History Survey for 1876. The hatching of the year confirmed the general correctness of this line; still more correctly it might have been drawn from Detroit to Princeton, thence southward to Austin, whence it moved southward across Iowa, passing nearly through Hardin, Story, Dallas, Madison, Adams and Taylor counties. But throughout all the eastern portion of this hatching area the young appeared in squads on scattered hatching grounds, and no doubt careful search might have found still others east of the limits given, the young of the swarms straggling eastward late in the fall, and finally disappearing, no one knew where.

It would be interesting to learn also the extreme northeastern limit of the appearance of the species. It lies somewhere in a region of woods and swamps north of the Northern Pacific and east of the longitude of Brainerd. This almost uninhabited region, though not lying in the usual line of flights, might be traversed by swarms in almost any summer and the fact remain unheard of. It is certain that locusts in years past have been seen in swarms, or in small numbers on the ground, at Red Lake, Leech Lake, Gull Lake, Brainerd, Aitken and Duluth, while several years ago locusts injured the vegetables and grass upon the island opposite Ashland, Wisconsin. All these points lie in a region which the locust is supposed to avoid. But even if it is possible for this insect to choose by instinct a certain line of flight, and to select the winds which will carry it in that general direction, it is carried at times to situations which the most trifling amount of instinct would cause it to shun, and has been found in immense numbers in the waters of Lake of the Woods, Red Lake, and in fewer numbers in Lake Superior. The northeastern limit of flight depends, partly at least, upon the point where swarms cross our border, and those coming in well to the east on the Manitoba line might, as in 1856, be carried into the Upper Mississippi Valley. The swarms of that year were no straggling bands, blown out of their course late in the season, but came in immense numbers, which by the testimony of all who remember the event, were many times more numerous than any that have appeared in later years. These reached Gull Lake and the region around it near the end of July, and not only destroyed the

crops at Crow Wing and thence southward in the Upper Mississippi Valley (which has never since been injured between Crow Wing and Sauk Rapids,) but penetrated in monstrous numbers into the woods about Mille Lacs Lake where they bent down the pine branches with their weight. They penetrated in considerable numbers as far as Cambridge, Isanti Co., a point which was hardly reached by swarms of 1874, and was not visited in 1876. All those swarms of 1856 must have crossed the northern boundary well to the east, or must have turned their flight eastward over the very regions which the locust is supposed to avoid. It is also noticeable that they penetrated southward only to about the neighborhood of Shakopee.

This was an exceptional instance in some respects. and in the locust invasions which we are destined to suffer in the future, there will probably be occasional events which will seem to contradict all previous experience, and to make it impossible to lay down anything like general rules. It might happen that swarms in a long, warm, and dry autumn might pass a few miles farther east than they have ever appeared before, and leave eggs which in a following spring of excessive dryness, and with a thin growth of grain, would prove destructive to a large proportion of everything sown. For all that the species has a certain natural range, and though no line can be definitely drawn beyond which it can be predicted that the locust will never appear, the regions of habitual, frequent, and infrequent appearance will be ascertained, while there still remains the strong probability that with increase of cultivated acreage towards the mountain regions the appearance of swarms in Minnesota will become rarer than before. It may even become possible to predict the time of appearance at certain points, and to take an example, as swarms reached Sauk Rapids about Aug. 20th, 1856, Aug. 17th, 1874, and Aug. 11th and 18th, 1876; as they reached Monticello Aug. 13th to 16th, 1856, Aug. 17th, 1874, and Aug. 18th, 1876, it is not probable that they will often reach the Upper Mississippi before the middle of August, or will often prove destructive to any great distance beyond it, either in a summer of invasion or in the spring following.

Finally, if there is in future any fear that Minnesota may become a permanent breeding ground of the locust, it may be said that so far as is known there is no permanent breeding ground of the species in any strict sense of that term. The species is migratory, and until it loses this habit there is no fear that the swarm which hatch here will remain to breed by natural increase. They may remove but partially, or to a short distance only, or they may be replaced by others in the same season, but in any case the instinct, the impulse, or the chance wind which brings them upon us will eventually remove their offspring.

The reference on the 2d page of this report to damage inflicted by the Chinch Bug may be found on pp. 17 and 18 of the Report of the Commissioner of Statistics for 1877, as follows:

"The crop of 1876 was menaced by three destructive agencies. The one already mentioned—heat drouth or whatever it was; the dreadful locust, whose flickering wings filled the air in the western portions of the state from the earth to the highest point of human vision; and locally, in Houston county, the chinch bug, where considerable damage was inflicted by this new foe to our great staple.

* * * * * * the third was not of sufficient magnitude to warrant the precise ascertainment of it—but it is a dangerous and insidious foe, and doubly dangerous because it is insidious, and should the coming year be marked with their renewed attacks, they should be carefully studied and their characteristics reported."

Upon page 97 of the same report the Commissioner quoted the following letter:

CALEDONIA, HOUSTON CO, MINN.
December 10, 1877.

*T. M. Metcalf, Commissioner of Statistics:*

SIR:—In reply to your inquiries as to the ravages of the Chinch Bug in this county, I cannot say much.

These pests are a mystery to me, and to every one of whom I have inquired, and I have not been able to find out much about them.

They are here now; they have charged the earth with eggs ready for the hatching temperature of earliest Spring, when, I fear, our farmers here will catch it again. I learn that they are at Fountain, on the Southern Minnesota Railroad, in myriads.

It is estimated that they destroyed two-fifths of the wheat crop of this county in 1877.

The *bee theory* has been tried on them. They smell like a bed-bug, and one can detect their presence by the smell in walking through the fields. They also manifest themselves by the change in the color of the grain. Their season is when the grain is in the "milk," just before harvest.

They do no injury at all before that time.

It is said that they were here before—just at the close of the war. Some of them live in the ground, under the stools of the grain through the winter, but most of them leave their eggs and die in the fall.

They work in a small patch, and all that are in that patch get together at night in a large pile, like ants in a hill, and the boot-heel, and hot water, with aid of lanterns, are used; but this is a slow process. When they finish a small patch, they move to another part of the field.

They were not troublesome in the western part of this county, nor were there many, if any, in adjoining counties.

Very Respectfully,
Yours, &c.,
E. W. TRASK,
Auditor of Houston Co,

I have received the following letter from the same source :

DEAR SIR:—Your favor of the 19th inst. requesting information concerning chinch-bugs, rye, &c, came duly. The chinch bugs promise mischief again this year in this county. They are very thick in the fields. We are a little in hopes that frequent cool showers will keep them back, and the early season ripen the grain before they do much damage. Some, not much, winter-rye is sown. The bugs do not trouble that much I am informed.

Respectfully,
E. W. TRASK,
Auditor of Houston Co.

CALEDONIA, MINN. May 22, 1878.

Crop reports in the St Paul Pioneer Press during the past month mention the presence of the chinch bug in other localities. As it may be necessary for farmers to take what precautions they can against this most dangerons insect, I here briefly digest the substance of several entomological reports upon the chinch bug, with the hope that the republication of these notes in the newspapers may add something to the knowledge of those who are not practically acquainted with it. Riley's Seventh Annual Report for the State of Missouri (pp. 19-50) describes (with figures) the insect in full, its habits natural enemies, and the best methods of contending with it. Fitch's 2d Entomological Report for the State of New York. Harris, Insects injurious to Vegetation, and Prof A. S. Packard's Report on the Locust and other Insects in the western States and Territories contain interesting and valuable information on the same subjects.

### THE CHINCH BUG.

Mentioned in various agricultural and entomological reports under the scientific names of *Lygaeus Leucopterus*, *Rhyparochromus Leucopterus*, *Micropus Leucopterus*, *Blissus Leucopterus*.

An hemipterous (half-winged) insect of the sub-order of *Heteroptera;* emitting, like many insects to which it is related, and for some of which it is easily mistaken, a nauseous (bed-buggy) odor.

A sucking (haustellate) insect, furnished with a sharp-pointed beak, subsisting upon the juices of grasses and cereals. Found while young feeding upon the roots and afterwards upon stalks and leaves.

The adult insect is about three-twentieths of an inch in length; the body is long, blackish, and hairy; the wings and fore wings are white, while the latter have a black spot upon the middle of the edge; legs dark yellow. Some ten varieties (including one wingless) are found differing more or less in color, but in general the species may be easily distinguished by the white fore wings with the black spot upon the edge.

The adult insects pass the winter hidden about the edges of fields, "under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass, or weeds or straw, and often in cornstalks and cornshucks.—*Riley*.

These come forth in the warm spring, pair, and the female deposits her eggs, laying them from day to day for about twenty days, underground upon the roots of the plant destined for food. These are laid in clusters, and are about three one-hundredths of an inch long, and pale amber-colored. They hatch in about two weeks, and the wingless young, bright red in color, may be found around and clinging to the roots where they have been hatched. These acquire wings in about six weeks, and after pairing, produce a second brood which lives through the winter, as stated above.

The insects may be seen upon the wing at pairing time, but do not take to flight readily. Their migrations are performed mostly on foot, in the growing stages, and from one field to another.

For the purpose of destroying the adult insects in the fall and winter, and to prevent future multiplication, the corn-stalks, dry weeds, rubbish, &c., about the fields, should be burned, or these with boards, or anything under which the insects may take shelter, may be left around the fields, for the purpose of trapping them.

As the female endeavors to penetrate below the surface of the ground for the pupose of depositing her eggs about the roots of plants, rolling after seeding tends, by hardening the ground, to prevent the deposit of eggs.

Early sowing and invigorating the plant with manure tend to bring forward the crops before the young are capable of doing their greatest injury.

As Hungarian grass is a favorite food of the chinch bug, a rod or two of it sown around a field of wheat tend to keep the young occupied until the wheat is out of danger. It is also recommended to sow with each 12 bushels of winter wheat one bushel of winter rye, as the bugs will destroy the rye in preference to the wheat; or to surround or intersperse grain crops with hemp, flax, castor beans, or buckwheat. Whenever badly infested patches of grain are noticed early in the season, straw should be spread over them and burned.

The migrations of the young, on foot, are prevented by boards set on edge along fields, and smeared with tar; or by coal tar poured along on the ground; or by running along the edge of fields a furrow turned outward, in which the insects may be destroyed by dragging, burning, or in pit-holes.

Excessive moisture, (rain, etc.) are destructive to the chinch bug; hence wherever continued irrigation is possible the insects may always be destroyed while still underground.

Among the natural enemies of the chinch bug are several species of Lady Bird, the Insidious Flower Bug, and the many-Banded Robber, (of insects), and the quail, as well as (perhaps) the prairie-chicken and red-winged black-bird.

As before stated, many insects closely related to the chinch bug, having nearly the same form and smell, may be easily mistaken for it. Perhaps the most common of these is the False Chinch Bug (Nysius Destructor). [I found these in abundance (pairing) around Monticello, June 14, in cornstubble and around purslane; they were mistaken for the chinch bug by those who had seen the latter repeatedly].

The chinch bug is a southern rather than a northern species of insect, but it has been found in Wisconsin considerably farther north than in Minnesota, and Prof Packard has found it in Maine and on the summit of Mount Washington. He infers that it is found in the colder as well as warmer portions of New England, and adds. "It probably inhabits the entire United States east of longitude 100°, and will probably occur in the western Territories, wherever wheat is raised, though perhaps the altitude and peculiar climatic features of the Rocky Mountain Plateau may prevent its rapid and undue increase."

It has years of excessive multiplication, like the locust, and other insects. In 1864 it was exceedingly destructive in the Mississippi Valley. In 1868 it did considerable damage in Southern Illinois and Southwestern Missouri. In 1871 and 1874 it was again very destructive—in the former year the losses were estimated at thirty, and in the latter at sixty million dollars, the losses in Missouri alone amounting to ninteen millions. (Riley). In such years as these its control passes beyond the hands of man, and it is only possible to mitigate its ravages to some extent, by earnest and united efforts.

Respectfully submitted,

ALLEN WHITMAN.

# XI.

## ORNITHOLOGY.

### REPORT OF DR. P. L. HATCH.

*Prof. N. H. Winchell:*

DEAR SIR :—In accordance with your request I have the pleasure to report a satisfactory advancement of the ornithological survey of the State during the past year. Personally, and through the assistance of competent observers, representative localities remote from the settlements have received special attention, particularly those embracing water-courses, and heavily timbered districts. Many important facts pertaining to the migration, distribution, feeding, and breeding of some species about which hitherto very little has been known, have been obtained which will be valuable in the further prosecution of the survey. Another of these facts, notably, is the intermixture of varietal forms representing different avi-faunal provinces. The western borders of the State have long been known to be interchangeable grounds, but it appears that most other portions partake of the same characteristics. I merely allude to these things to indicate to you some features of the work to be accomplished. If it were only the listing of species found to be what is commonly called *resident birds*, my previous work, together with my co-laborers in the Minnesota Academy of Natural Sciences, would leave comparatively little to be done. But it embraces the largest measure of attainable data in everything pertaining to the esthetic and economic relationships of the birds to the commonwealth.

To accomplish so much, or to approximate it necessitates the employment of all available aid and considerable time. I regard myself highly favored in having the co-operation of several competent collectors in the different sections of the State and especially a number of young men residing in this city. They have already contributed notes on the habits of some rare species that are of

great value which will appear in my final report, when each will be duly accredited with all that he has done.

With this abbreviated general statement of what I have accomplished during the year, reserving details for a final report, I remain

Yours respectfully,

P. L. HATCH.

818 Nicollet Avenue, Minneapolis, May 1, 1878.

# XII.

## RAILROAD ELEVATIONS.

BY E. S. ALEXANDER.

*ELEVATION on the Hutchinson branch of the Minneapolis and Northwestern Railway—Commencing 11.6 miles west of Minneapolis, on the line of M. & St. L. Railway, thence westward through counties of Hennepin, Carver and McLeod, to Hutchinson—from notes of preliminary survey made in November, 1877.*

| Miles from St. P.&P. Ry Depot. | | Elevation above Ocean. |
|---|---|---|
| 11.6 | Island Lake (M. & St. L. railway track) | 893 |
| | " " (surface of water) | 881 |
| 12.2 | | 903 |
| 13.4 | Town-line between Eden Prairie and Minnetonka townships 1¼ miles east of northwest corner of E. P. township (ground) | 842 |
| | Bottom of Purgatory creek | 838 |
| 15.6 | Town-line, Minnetonka and Excelsior townships, ½ mile north of township corner (ground) | 881 |
| 15.8 | Opposite north end of Silvine or German Lake (water—about) | 881 |
| 16.9 | Summit of ridge between Silvine and Christmas lakes | 978 |
| 17.1 | Ridge south of Christmas Lake | 997 |
| | Christmas Lake (water—about) | 920 |
| 18.2 | Lake Lucy (ground) | 945 |
| | " " (water) | 943 |
| 19.3 | On west line of section 3 near ¼ corner Chanhassan township. This is on a narrow ridge 15 feet above the tamarack swamp on west, and 20 feet above tamarack swamp on east; the hills on each side are sixty or seventy feet higher than the swamp | 989 |
| 20.0 | Minnewashta Lake (water) | 934 |
| 20.7 | North line of Chanhassen township, in front of school house No. 59 | 972 |
| 21.8 | Virginia Lake (water) | 919 |
| 22.7 | Outlet of Virginia Lake—head of Lake Minnetonka—old site of Smithtown (water of Minnetonka) | 917 |
| | From here the line follows around the south side of Lake Minnetonka and Halsted's bay to 26.2 miles. Bluffs are from 80 to 100ft. high. | |

| Miles from St. P.&P. Depot. | | Elevation above Ocean. |
|---|---|---|
| 26.5 | Ridge between Six-mile creek and Halsted's bay | 943 |
| 26.6 | Marsh of Six-mile creek | 919 |
| 26.7 | Six-Mile creek (bottom) | 913 |
| 28.8 | 500 feet north of the center of section 20, Minnetrista township—outlet of large cranberry marsh | 973 |
| 29.2 | Watershed between Lake Minnetonka and Crow river | 981 |
| 31.3 to 32.2 | On south edge of Picture or Mud Lake (water) | 929 |
| 32.2 | Center of section 14, Watertown township | 931 |
| 33.3 | | 983 |
| 35.1 | Crow River (bluff on east side) | 965 |
| 35.8 | " " (Watertown mill-dam) | 916 |
| | " " (bottom of river) | 910 |
| 36.7 | 1,900 feet north of southwest corner of section 8, Watertown Tp., (grassy swamp) | 926 |
| 39.9 | | 981 |
| 43.0 | Ocean Marsh (grassy marsh) | 988 |
| 43.9 | County-line between Carver county and McLeod | 1,014 |
| 44.4 | Outlet of Winsted Lake [dry bottom] | 981 |
| 44.6 | Winsted Lake, south side [top of bluff] | 1,003 |
| | " " [water] | 985 |
| 46.9 | | 1,026 |
| 48.7 | | 1,029 |
| 49.7 | | 1,048 |
| 52.0 | | 1,040 |
| 54.0 | 1,400 feet west of the southeast corner of section 28 in Hale township —half mile north of Silver Lake post-office | 1,051 |
| 55.3 | | 1,074 |
| 56.0 | Swan Lake [water] | 1,036 |
| 56.4 | | 1,066 |
| 57.5 | Bear creek | 1,037 |
| 58.6 | Leave Big Woods and enter the rolling prairie | 1,058 |
| 61.7 | Crow River [bluff] | 1,068 |
| 62.1 | " " [water] | 1,020 |
| | " " [bottom] | 1,017 |
| 62.4 | Hutchinson | 1,033 |

The above levels do not give a correct idea of the nature of the country—which is very rough as far as Watertown.

From 12.5 miles to 15.8 miles the line follows the valley of Purgatory Creek, whose bluffs roll back to a height of about 70 feet in quarter of a mile.

At 17.0 miles the line crosses a ridge which runs northeasterly and southwesterly. This ridge, compressed to a width at the base of 500 or 600 feet between lakes Silvine and Christmas, widens out both southwest and northeast. It prevents Lake Minnetonka from draining into Purgatory creek—although that valley is nearly forty feet lower than the lake—and flowing thence into the Minnesota river.

The bluffs on Lake Minnetonka rise abruptly to hight of about 80 feet, and a few hundred feet back are 100 feet above the lake. The line runs around on the foot of the bluffs.

From Six Mile creek the line follows up a small valley to 29.2 miles where it crosses the watershed. At this place there are hills on each side which must be 80 feet higher.

From here it follows down a small ravine between high hills to Picture Lake. On the north, south, and northeast sides of this lake the hills rise abruptly about one hundred feet.

From here to Watertown the country is not so broken.

From 36.5 miles the line follows up a small valley—whose bluffs are about 40 feet high—to 39.9 miles.

From this point to Hutchinson the general level of the country is very well shown by the table. It is rich and rolling, the knolls rise ten, twenty, and sometimes thirty feet above the depressions.

[The red hardpan drift, in a modified condition, extends, *via* Hopkins Station, past the east end of Lake Minnetonka, and to within perhaps five or six miles of Excelsior. The drift knolls that seem to extend in a nearly continuous series along the south side of the Lake Minnetonka consist of this red drift. There are occasional places of sandy surface, and others of red loam, but the most of the surface is of a red gravelly loam that seems to be derived from a slight mixing of the gravelly sub-soil with a thin loam that probably corresponds to the loess loam of further east. On these knolls the soil is the same, but is much thinner, or almost destitute of loam.

On the road to Wayzata, from Minneapolis, the red drift continues to the Half-way House about seven miles from Minneapolis. Thence westward, along the north side of Lake Minnetonka, the surface is one of gray hardpan. N. H. W.]

# XIII.

## REPORT ON THE GENERAL MUSEUM,

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR THE YEAR 1877.

*By N. H. Winchell, Curator.*

The principal work during the year has been the opening, cataloguing, and placing on exhibition of the Kunz collection of minerals. On the completion of the twelve cases designed for minerals and fossils, which are constructed on the plan of similar cases in the Smithsonian Institution at Washington, these specimens were deposited therein. They were subsequently re-handled and neatly labeled with a form of printed label. In the same cases have been placed a part of the fossils of the Trenton formation which have been studied. The duplicates of the species of the Kunz collection, which constitute nearly one-half of its bulk, have also been examined, recorded in the register, and re-boxed. They will shortly be offered for exchange, ar d in that way will serve to increase the number of species in the Museum.

The *Megatherium* skeleton, a part of the collection purchased of H. A. Ward several years ago, was unboxed for the first time since its delivery at the University, in the summer of 1877, and carried to the north room of the Museum preparatory to mounting. Unavoidable circumstances, much to be regretted, have delayed this to the present, and the room, on the floor of which it is spread out, has necessarily been closed to promiscuous admission of the public, though interested visitors have been admitted on application.

Two other upright cases have also been built in the north room, uniform with those reported last year, designed for the exhibition of birds, thus furnishing the walls of the room with all the cases they will accommodate. In one of these cases Mr. Herrick has placed a number of our native birds, tastefully and naturally

mounted, and arranged on artificial supports. The ornithological observations of Mr. Herrick during the year have been reported to Dr. Hatch, for use in preparing a final report on the ornithology of the State.

In addition to the birds added to the Museum, a number of plant-specimens have been preserved by Mr. Herrick; and others have been presented by Mr. B. Juni.

The fossils collected from the Trenton limestone at Minneapolis are mostly entered in the Register, though as yet unstudied.

A collection of marine specimens from the coast of Virginia was presented by Ex-Governor Horace Austin, comprising the following species:

1. Flying Gurnard. *Perinothus* (sp?)........................1 specimen.
2. Weak Fish. *Otolithus regalis. Cuv. and Val*..............1 specimen.
3. Toad Fish. *Batrachus tau. Linn*..........................1 specimen.
4. Perch. *Perca* (sp?)......................................3 specimens.
5. Fiddler crab. *Gelasimus vocans. Milne Ed*................1 specimen.
6. Crap. *Lupa* (sp?)........................................5 specimens.
7. *Brachyuran crustaceans*..................................3 specimens.
8. Sea Urchin. *Echinus* (sp?)...............................2 specimens.
9. Brittle Star. *Ophiura* (sp?).............................1 specimen.
10. Star Fish. *Asterias* (sp?)..............................2 specimens.

These have been placed in suitable bottles in alcohol, and form, together with other specimens collected in the Custer Expedition to the Black Hills in 1874, and others preserved last year, the nucleus of a collection of the invertebrate and lower vertebrate animals which will be of much interest.

A specimen of the so-called Jack Rabbit was obtained at Lake Shetek in Murray county, where was also found the common eastern species. This is probably nearly on the eastern limit of the range of the Jack Rabbit. A few skulls are mounted on suitable pedestals, viz.: *Ovis*, *Canis*, and *Felis*, to which others will be added.

The following catalogue shows the name, number, and source of the geological and mineralogical specimens added during the year, exclusive of the collection of several boxes in the prosecution of the field work of the Geological Survey, and only so far as the same have been examined and labeled.

# CATALOGUE OF SPECIMENS REGISTERED

*in the General Museum in 1877.*

| Serial Number. | Obtained. When. | Obtained. Whence. | NAmE. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 90 | .......... | Dr. Stoneman..... | Asaphus extans. H. Compare 399.............. | 1 | .......................... | Trenton ... | Has tuberculated surface in- [stead of lamellose. |
| 172 | Oct. 1872 | Geol. Sur.......... | Block with schizocrinus nodosus. H. Murchisonia. sp. ? and the head of a trilobite.... | 1 | Pleasant Grove, Olm Co. | " .. | N. H. Winchell................. |
| 185 | 1875. | " .......... | Slabs containing Strophomena. (Specimens. Orthis Chetætes *et al.*...... ................. | 1 | Fillmore Co............ | " .. | " ................ |
| 186 | " | " .......... | Orthis perveta. Con. (Larger than the type. | 4 | Fount'n in Fillmore Co. | " .. | " (Taylor's Quarry) |
| 189 | " | " .......... | Fragments of Asaphus gigas. H.............. | 1 | Fillmore County........ | " .. | N. H. Winchell................. |
| 191 | " | " .......... | Slab with Leptaena sericea. Sow. Orthis emacerata. H. Strophomena filitexta. H. Strophomena nitens. Bill................. | 1 | " " ........ | " .. | " ................. |
| 192 | " | " .......... | Slab with Poteriterinites caduceus. H. Orthis testudinaria. Dal. Rhynchonella capax. Con. Chaetetes Lycoperdon. H. Leptæna sericea. Sow..................... | 1 | " " ........ | " .. | " (The Potteriocrinus-Dendocrinus C. according to Miller. |
| 194 | " | " .......... | Part of buckler of Asaphus gigas............... | 1 | " " ........ | " .. | N. H. Winchell................. |
| 197 | " | " .......... | Orthoceras laqueatum. H. ?..................... | 1 | Spring Valley... ...... | " .. | " (Com. 214.)...... |
| 208 | " | " .......... | Strophomena tenuistriata. (?).......... ...... | 1 | Sec. 17, Roch't'r, Olm Co. | Galena.... | M. W. Harrington, (Garirick's quarry,) Compare 311, 204.) |
| 214 | " | P. W. Thayer, Geol. Survey.... | Orthis testudinaria. Dal. Murchisonia bicincta. H. Orthoceras laqueatum. H. Leptæna sericea. Sow. Bellerophon bilobatus. Sow. Strophomena nitens. Bill. Rhynchonella capax. Con.................. | 1 | Spring Valley, Fill. Co. | Trenton ... | N. H. Winchell................. |
| 228 | Oct. 1875 | Geol. Sur.......... | Leptæna serica.Sow............................ | 1 | Fillmore Co............ | " .. | " ................ |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 242 | Oct. 1875 | Geo. Sur. | Cyrtoceras arcuatum. Hall | 2 | Holden, Goodhue Co. | Trenton | N. H. Winchell |
| 243 | " | " " | Oncoceras constrictum. Hall | 1 | " " | " | " |
| 244 | " | " " | Asaphus gigas. H. (Left maxillary portion, or cheek.) | 1 | " " | " | " |
| 245 | " | " " | Fragments of Asaphus gigas. Hall | 3 | " " | " | " |
| 252 | July, 1875 | " " | Orthoceras vertebrale. Hall | 1 | " " | " | " |
| 254 | Oct. 1875 | " " | Receptaculites | 1 | Lime City, Fillmore Co. | " | " |
| 258 | " | " " | Cyrtoceras ? sp. ? | 3 | " " | " | " |
| 264 | Sept. 1875 | " " | Slabs with Strophemena and Orthis | 2 | Olmsted Co. | " | " |
| 269 | " | " " | Orthis subquadrata. Hall | 1 | Sec. 30, Forestville Fillmore Co. | " | " |
| 279 | Oct. 1875 | " " | Orthis. n. sp. | 1 | Minneapolis. | " | " Same as 648, 346. |
| 293 | Sept. 1875 | " " | Strophomena fluctuosa. Bill | 1 | Mantorville, Dodge Co. | Galena | M. W. Harrington, (Upper layers Wilson's quarry.) |
| 294 | " | " " | Graptolithus scalaris. Linn | 1 | " " | " | M. W. Harrington, (Upper layers Wilson's quarry.) |
| 295 | " | " " | Graptolithus. ? | 1 | " " | " | M. W. Harrington, (Upper layers Wilson's quarry.) |
| 296 | " | " " | Discina Pelopea. Bill. (263.) | 1 | " " | " | M. W. Harrington, (Upper layers Wilson's quarry.) |
| 307 | Oct. 1875 | " " | Chætetes petropolitanus, Pander ? | 1 | Sec. 21, Forestville, Fillmore Co. | Trenton | N. H. Winchell |
| 321 | " | " " | Orthis. n. sp. | 2 | Minneapolis | " | " |
| 322 | " | " " | Orthis perveta. Con | 1 | " | " | " Different form. |
| 323 | " | " " | Rhynchonella capax. Con | 3 | " | " | " " " |
| 324 | " | " " | " " " | 5 | " | " | " " " |
| 325 | " | " " | " " " | 2 | " | " | " " " |
| 326 | " | " " | " " " | 1 | " | " | " " " |
| 327 | " | " " | Orthis emacerata. H. var. multisecta. James. | 1 | " | " | " |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | OBTAINED. When. | OBTAINED. Whence. | NAME. | No. of Specimens. | Locality | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 328 | Oct. 1875. | Geol. Sur. | Rhynchonella capax. Con. (v. 220). | 1 | Minneapolis | Trenton | N. H. Winchell, Different form. |
| 331 | 1873 | " " | " " " | 6 | Minneap'lis, Finn's Glen | " | " Different form. |
| 334 | " | " " | Crinoid joints—(Schizocrinus nodusus H.) | 4 | " " " | " | " |
| 335 | " | " " | Crytolites compressus. Con. | 1 | " " " | " | " |
| 338 | " | " " | Orthis, n. sp. | 1 | " " " | " | " |
| 339 | 1872 | " " | Orthis, n. sp. | 4 s'bs | Rochester, Olmsted Co. | " | N. H. Winchell—Whitcomb's Quarry, same as 346, 279, 648. |
| 346 | " | " " | Orthis, n. sp. | 3 | " " " | " | N. H. Winchell, same as 279, 648. |
| 347 | " | " " | Schizocrinus nodosus. H. (Stem) | 1 | Sec. 16, Pleasant Grove. | " | " |
| 348 | " | " " | Cyrtolites compressus. Con. | 1 | " " " | " | " |
| 350 | " | " " | Orthoceras strigatum. H. | 1 | " " " | " | " |
| 351 | " | " " | Slab containing chætetes Lycoperdon. H. | 1 | Pettit's Mill | " | " |
| 352 | " | " " | Oncoceras constrictum. H. | 1 | Pleasant Grove | " | " |
| 356 | " | " " | Strophomena. (sp. undistinguishable) | 1 | " " | " | " This shell is also found at Mantorville. |
| 371 | " | " " | " (tennistriata? v. No. 204 and 208. | 1 | Nr Rochester, Olmst'd Co | Galena | " |
| 374 | " | " " | Orthis | 12 | St. Charles | Trenton | " |
| 376 | " | " " | Asaphus gigas. H. | 1 | " | " | " |
| 379 | " | " " | Orthoceras vertebrale. H. | 1 | " | " | " |
| 381 | " | " " | Orthoceras strigatum. H. | 2 | Pleasant Grove, Olm. Co. | " | " |
| 392 | Oct. 1872. | " " | Block with fragment of Orthis bella-rugosa. Con. | 1 | St. Charles | " | " |
| 395 | " | " " | Orthis | 1 | Rochester, Olmsted Co. | " | " Same as 652. |
| 399 | 1872 | W. D. Hurlbut | Asaphus extans. H. (?) v. 90 | 1 | Trenton Falls, N. Y. | " | " Has a pustulated instead of a lamellose surface. |
| 410 | Oct. 1872. | Geol. Sur. | Asaphus gigas. H. and Strophomena filitexta. H | 1 | St. Charles | " | N. H. Winchell. |
| 429 | Oct. 1875. | " " | Orthis. n. sp.? | 2 | Spring Valley | Galena? | N. H. Winchell, (ventral valve is the most convex and hence cannot be Orth's occidentalis, v. Pal. Ohio vol. I. p. 96. The plications are also too coarse. |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 635 | Nov. 1876 | Centennial Exb | Volcanic Scoria | m'y | Kilauea, Sandwich Isl. | | |
| 636 | " | " " | " " Pele's Hair | 1 | " " " | | |
| 637 | Aug. 1873 | Geol. Sur | Kaoline (green and impure) | 1 | Birch Coolie, Minn. | | Cut in rectangular block |
| 638 | " | " | " " " | 1 | " " " | | Natural specimen |
| 639 | Nov. 1876 | Centennial Exb | Lava tears | 2 | Kilauea, Sandwich Ils. | | |
| 640 | Oct. 1872 | Geol. Survey | Limonite (after Pyrite) | 1 | Sugar Loaf, Winona | Low. Mag. | Surface specimen |
| 641 | Nov. 1876 | Centennial Exb | Water Crystals. (Quartz.) | 4 | Little Falls, N. Y. | | |
| 642 | Oct. 1875 | Geol. Sur | Orthis. n. sp? | 2 | Spring Valley | Galena | N. H. Winchell |
| 643 | " | " | Orthis | 2 | Minneapolis | Trenton | " |
| 644 | Aug. 1875 | " | Orthis | 4 | Fountain, Fillmore Co. | " | " (Taylor's Quarry.) |
| 645 | " | " | Lingula quadrata. Eich | 1 | " " " | " | " " " |
| 646 | " | " | Chætetes Lycoperdon. H | 9 | " " " | " | " " " |
| 647 | " | " | Strophomena filitexta. H. Pal. vol. I, p. 82 (one ventral valve | 1 | " " " | " | " " " |
| 648 | " | " | Orthis. n. sp? | 1 | " " " | " | N. H. Winchell, same as 279, 346. |
| 649 | Sept. 1875 | " | | Indf | Olmsted Co. | " | M. W. Harrington |
| 650 | ? | " | Rhynchonella capax. Con | 1 | ? | | ? |
| 651 | Aug. 1875 | " | Orthis. n. sp | 1 | Fountain, Fillmore Co. | Trenton | N. H. Winchell |
| 652 | 1872 | " | Slabs with Asaphus gigas H. Orthis testudinaria, Dal. and a small Rhynchonellas, also a Gasteropod. | bks 6 | Rochester, Olmsted Co. | " | " |
| 653 | July 1877 | " | Cyrtolites compressus. Con | 6 | Minneapolis | " | C. L. Herrick |
| 654 | 1873 | " | Ceraurus vigilans H | 1 | Finn's Glen | " | N. H. Winchell |
| 655 | Oct. 1872 | " | Leptaena sericea. Sow | 1 | Petit's Mill | " | " |
| 656 | " | " | Schizocrinus nodosus, H | 1 | " | " | " |
| 657 | " | " | Slab with Rhynchonella capax, Con. and Strophomena alternata. H. and Bellerophon ilobatus, H | 1 | " | " | " |
| 658 | " | " | Calcareous tufa | 1 | Minneapolis | | C. L. Herrick |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial No. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 659 | 1872...... | Geol. Sur......... | Atrypa recurvirostra. H.................Blocks | 6 | Rochester, Minn........ | Trenton... | N. H. Winchell.................. |
| 660 | " ...... | " .......... | Atrypa recurvirostra. H........................ | Indf | " " ........ | " ... | " (taken from 659.) |
| 661 | Oct. 1872 | " .......... | Endoceras proteiforme, var. lineolatum. H... | 1 | Pleasant Grove, (sec. 16) | " ... | " .................. |
| 662 | " | " .......... | Orthoceras junceum. H........................ | 1 | " " | " ... | " .................. |
| 663 | " | " .......... | Cytoceras annulatum. H. and Orthoceras strig. H | 1 | " " | " ... | " .................. |
| 664 | Aug. 1877 | " .......... | Petraia corniculum. H........................ | Indf | Minneapolis............ | " ... | C. L. Herrick.................. |
| 665 | " | " .......... | ............................................ | 2 | " ............ | " ... | " .................. |
| 666 | " | " .......... | ............................................ | Indf | " ............ | " ... | " .................. |
| 667 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 668 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 669 | " | " .......... | ............................................ | 14 | " ............ | " ... | " .................. |
| 670 | " | " .......... | ............................................ | 7 | " ............ | " ... | " .................. |
| 671 | " | " .......... | ............................................ | 2 | " ............ | " ... | " .................. |
| 672 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 673 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 674 | " | " .......... | ............................................ | 9 | " ............ | " ... | " .................. |
| 675 | " | " .......... | ............................................ | 4 | " ............ | " ... | " .................. |
| 676 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 677 | " | " .......... | ............................................ | 2 | " ............ | " ... | " .................. |
| 678 | " | " .......... | ............................................ | 2 | " ............ | " ... | " .................. |
| 679 | " | " .......... | ............................................ | 2 | " ............ | " ... | " .................. |
| 680 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 681 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 682 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 683 | " | " .......... | ............................................ | 12 | " ............ | " ... | " .................. |
| 684 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |
| 685 | " | " .......... | ............................................ | 1 | " ............ | " ... | " .................. |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. | | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 686 | Aug. 1877 | Geol. Sur. | | 1 | Minneapolis | Trenton | C. L. Herrick |
| 687 | " | " | | 3 | " | " | " |
| 688 | " | " | | 1 | " | " | " |
| 689 | " | " | | 1 | " | " | " |
| 600 | " | " | | 1 | " | " | " |
| 691 | " | " | | 1 | " | " | " |
| 692 | " | " | | 4 | " | " | " |
| 693 | " | " | | 1 | " | " | " |
| 695 | " | " | | 1 | " | " | " |
| 696 | " | " | | 2 | " | " | " |
| 697 | " | " | | 2 | " | " | " |
| 668 | " | " | | 1 | " | " | " |
| 699 | " | " | | 4 | " | " | " |
| 700 | " | " | | 1 | " | " | " |
| 701 | " | " | | 5 | " | " | " |
| 702 | " | " | | 2 | " | " | " |
| 703 | " | " | | 2 | " | " | " |
| 704 | " | " | | 1 | " | " | " |
| 705 | " | " | | 7 | " | " | " |
| 706 | " | " | | 1 | " | " | " |
| 707 | " | " | | 2 | " | " | " |
| 708 | " | " | | 3 | " | " | " |
| 708 | " | " | | 1 | " | " | " |
| 709 | " | " | | 1 | " | " | " |
| 710 | " | " | | 1 | " | " | " |
| 711 | " | " | | 1 | " | " | " |
| 712 | " | " | | 1 | " | " | " (Green slade.) |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 713 | Aug. 1877 | Geol. Sur. | | 2 | Minneapolis | Trenton | C. L. Herrick (Green shale) |
| 714 | " | " | | 1 | " | " | " " " |
| 715 | " | " | | 1 | " | " | " |
| 716 | " | " | | 6 | " | " | " (Green shale) |
| 717 | " | " | | 1 | " | " | " " " |
| 718 | " | " | | 1 | " | " | " |
| 719 | " | " | | 1 | " | " | " |
| 720 | " | " | | 2 | " | " | " |
| 721 | " | " | | 2 | " | " | " |
| 722 | " | " | | 1 | " | " | " |
| 723 | " | " | | 1 | " | " | " |
| 724 | " | " | | 1 | " | " | " |
| 725 | " | " | | 1 | " | " | " |
| 726 | " | " | | 1 | " | " | " |
| 727 | " | " | | 1 | " | " | " |
| 728 | " | " | | 1 | " | " | " |
| 729 | " | " | | 1 | " | " | " |
| 730 | " | " | | 1 | " | " | " |
| 731 | " | " | | 1 | " | " | " |
| 732 | " | " | | 1 | " | " | " (Green shale.) |
| 733 | " | " | | 2 | " | " | " " " |
| 734 | " | " | | Indf | " | " | " " " |
| 735 | " | " | | 2 | " | " | " " " |
| 736 | " | " | | 2 | " | " | " " " |
| 737 | " | " | | Indf | " | " | " " " |
| 738 | " | " | | " | " | " | Fragment of above " |
| 739 | " | " | | 1 | " | " | " " " |

*Catalogue of Specimens Rigistered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | Name. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 740 | Aug. 1877 | Geol. Sur. | | 2 | Minneapolis | Trenton | C. L. Herrick |
| 741 | " | " | | 1 | " | " | " (Green shale.) |
| 742 | " | " | | 3 | " | " | " " " |
| 743 | " | " | | 1 | " | " | " |
| 744 | " | " | | 3 | " | " | " |
| 745 | " | " | | 1 | " | " | " |
| 746 | " | " | | 1 | " | " | " |
| 747 | " | " | | 1 | " | " | " |
| 748 | " | " | | 2 | " | " | " |
| 749 | " | " | | 1 | " | " | " |
| 750 | " | " | | 1 | " | " | " |
| 751 | " | " | | 1 | " | " | " |
| 752 | " | " | | 1 | " | " | " |
| 753 | " | " | | 5 | " | " | " |
| 754 | " | " | | Indf | " | " | " (Green shale.) |
| 755 | " | " | | " | " | " | " |
| 756 | " | " | | 1 | " | " | " |
| 757 | Fall, 1876 | " | | 1 | " | " | N. H. Winchell |
| 758 | " | " | | 1 | " | " | " |
| 759 | " | " | | 1 | " | " | " |
| 760 | " | " | | 1 | " | " | " |
| 761 | " | " | | 1 | " | " | " |
| 762 | " | " | | 1 | " | " | " |
| 763 | " | " | | 1 | " | " | " |
| 764 | " | " | | 1 | " | " | " |
| 765 | " | " | | 1 | " | " | " |
| 766 | Aug. 1877 | " | | Indf | " | " | C. L. Herrick |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formotion | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 767 | Aug. 1877 | Geol. Sur. | | 5 | Minneapolis | Trenton | C. L. Herrick |
| 768 | " | " | | 2 | " | " | " |
| 769 | " | " | | 2 | " | " | " |
| 770 | " | " | | 1 | " | " | " |
| 771 | " | " | | 1 | " | " | " |
| 772 | " | " | | 1 | " | " | " |
| 773 | " | " | | Indf | " | " | " |
| 784 | " | " | | 4 | " | " | " |
| 775 | " | " | | 1 | " | " | " |
| 786 | " | " | | 1 | " | " | " |
| 777 | " | " | | 1 | " | | " |
| 778 | " | " | | 1 | " | | " |
| 779 | " | " | | 1 | " | | " |
| 780 | " | " | | 1 | " | | " |
| 781 | " | " | | 1 | " | | " |
| 782 | " | " | | 1 | " | | " |
| 783 | " | " | | 1 | " | | " |
| 784 | " | " | | 1 | " | | " |
| 785 | " | " | | 1 | " | | " |
| 786 | " | " | | 2 | " | | " |
| 787 | " | " | | 3 | " | | " (Green shale.) |
| 788 | " | " | | 1 | " | | " |
| 782 | " | " | | 1 | " | | " (Green shale.) |
| 790 | " | " | | 2 | " | | " " " |
| 791 | " | " | | 1 | " | | " " " |
| 792 | " | " | | 3 | " | | " " " |
| 793 | " | " | | 1 | " | | " " " |

## Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

| Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 794 | Aug. 1877 | Geol. Sur | | 2 | Minneapolis | | C. L. Herrick, (Green shale.) |
| 795 | " | " | | 1 | " | | " |
| 796 | " | " | | 1 | " | | " (Green shale.) |
| 797 | " | " | | Indf | " | | " " " |
| 798 | Jan. 1876 | Minn. D. J. Co | Serpentine. (Precious) | 3 | Newburyport, Mass. | | |
| 799 | Nov. 1876 | Cent. Exp. | Graphite | 2 | Rockingham, Ont | | Geol.Sur.of Can.(A.R.C.Selwyn) |
| 800 | " | " | Chalcopyrite | 1 | Almador Co., Cal. | | N. H. Winchell |
| 801 | ? | A. D. Roe | Dipyre | .... | Canaan, Conn. | | |
| 802 | Sept. 1873 | Geol. Sur | Gypsum, (Selenite Crystals) | Indf | Big Stone Lake, Minn. | Cretaceo's | N. H. Winchell |
| 803 | Sept. 1877 | " | Ankerite | 1 | Lanesboro, Minn. | St. Lawre'e | |
| 804 | Dec. 1877 | A. K. Ridenour. | Modiolopsis pholadiformis. F. & W. | 1 | Oxford, Ohio | Low Sil | |
| 805 | " | " | Rhynchonella perlamellosa. Whit | 2 | Clarksville, Ohio | " | |
| 806 | " | " | Ambonychia radiata. Hall | 1 | Cincinnati, Ohio | " | |
| 807 | " | " | Avicula corrugata. James | 1 | " | " | |
| 808 | " | " | Orthis testudinaria. Dal | 13 | " | " | |
| 809 | " | " | Orthis retrorsa. Sal | 1 | Oxford, O. | " | |
| 810 | " | " | Orthis dentata. Pander | 2 | Cincinnati, O. | " | |
| 811 | " | " | Strophomena loxorhytis. Meek | 2 | " | " | |
| 812 | " | " | Lingula covingtonensis. Hall. and Whit. | 1 | " | " | |
| 813 | " | " | Orthis subquadrata. Hall | 2 | Clarksville, O. | " | |
| 814 | " | " | Crania scabiosa. Hall | 3 | Cincinnati, O. | " | |
| 815 | " | " | Orthodesma contracta. Hall | 1 | " | " | |
| 816 | " | " | Orthis fissicosta. Hall | 2 | " | " | |
| 817 | " | " | Modiolopsis modiolaris. Con | 2 | " | " | |
| 818 | " | " | Orthis lynx. Eich | 1 | " | " | |
| 819 | " | " | Anodontopsis Milleri. Meek | 2 | Versailles, Ind. | " | |
| 820 | " | " | Orthis occidentalis. Hall | 1 | Cincinnati, O | " | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation. | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 821 | Dec. 1877 | A. K. Ridenour | Streptorhynchus elongata. James | 2 | Clarksville, O | Low. Sil | |
| 822 | " | " | Orthis acutilirata. Con | 2 | " | " | |
| 823 | " | " | Strophomena rhomboidalis. Sow | 2 | " | " | |
| 824 | " | " | Strophomena alternata. Hall | 2 | " | " | |
| 825 | " | " | Modiolopsis anodontoides. Con | 1 | " | " | |
| 826 | " | " | Rhynohonella capax. Con | 4 | " | " | |
| 827 | " | " | Orthis biforata. Eich | 4 | Cincinnati, O | " | |
| 828 | " | " | Tellinomya pecteneuloides. Hall | 3 | " | " | |
| 829 | " | " | Streptorhynchus planumbona. Hall | 2 | Clarksville, O | " | |
| 830 | " | " | Zygospira modesta. Say | 5 | Cincinnati, O | " | |
| 831 | " | " | Leptæna sericea. Sow | 8 | " | " | |
| 832 | " | " | Streptorhynchus sinuata. Em | 2 | Clarksville, O | " | |
| 833 | " | " | Orthodonta parallela. Hall | 1 | Cincinnati, O | " | |
| 834 | " | " | Streptorhynchus planoconexa. Hall | 2 | " | " | |
| 835 | " | " | Streptorhynchus subtenta. Con | 1 | Clarksville, O | " | |
| 836 | " | " | Trematis multipunctata. Hall | 4 | Cincinnati, O | " | |
| 837 | " | " | Murchisonia bicincta. Hall | 4 | " | " | |
| 838 | " | " | Orthis borealis. Bill | 2 | Frankfort, Ky | " | |
| 839 | " | " | Streptorhynchus sulcata. DeVer | 3 | Clarksville, O | " | |
| 840 | " | " | Zygospira Cincinnatiensis. James | 9 | Cincinnati, O | " | |
| 841 | " | " | Strophomena squamula. James | 3 | " | " | |
| 842 | " | " | Orthis insculpta. Con | 3 | Clarksville, O | " | |
| 843 | " | " | Schizocrania filosa. Hall | 1 | Cincinnati, O | " | |
| 844 | " | " | Tellinomya lavata. Hall | 1 | " | " | |
| 845 | " | " | Orthis plicatella. Hall | 6 | " | " | |
| 846 | " | " | Raphistoma lenticularis. Sow | 3 | " | " | |
| 847 | " | " | Orthis ella. Hall | 4 | " | " | |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued. 12

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimen. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 848 | Dec. 1877 | A. K. Ridenour | Orthis Jamesi. Hall | 4 | Cincinnati, O. | Low Sil | |
| 849 | " | " | Nucleospira fusiformis. Hall | 2 | Morrow, O. | " | |
| 850 | " | " | Orthis emacerata. Hall | 4 | Cincinnati, O. | " | |
| 851 | " | " | Tellinomya obliqua | 4 | Ohio | " | |
| 852 | " | " | Cleidophorus fabula | 3 | Ohio | " | |
| 853 | " | " | Avicula insueta. Con | 2 | Ohio | " | |
| 901 | Nov. 1876 | Geo. F. Kunz | Bog Iron ore No. 1 | 1 | Bulau bei Hanau | | |
| 902 | " | " | Freshwater limestone No. 2 | 1 | Binau | | |
| 903 | " | " | Loess No. 3 | 1 | Heidelberg | Loess | |
| 904 | " | " | Limestone No. 4 | 1 | Naples, Italy | | |
| 905 | " | " | Tertiary sandstone No. 5 | 1 | Heppenheim | Tertiary | |
| 906 | " | " | Molasse No. 6 | 1 | Bern, Switzerland | | |
| 907 | " | " | Calcareous Conglomerate No. 7 | 1 | Rigi, Switzerland | | |
| 908 | " | " | Sandstone No. 8 | 1 | Siebengebirge | | |
| 909 | " | " | Platic Clay No. 9 | 1 | Hemsbach | | |
| 910 | " | " | Porcelain Jasper No. 10 | 1 | Bilin, Bohemia | | |
| 911 | " | " | Brown Coal No. 11 | 1 | Teplitz, Bohemia | | |
| 912 | " | " | Lignite No. 12 | 1 | Salzhausen, Wetterau | | |
| 913 | " | " | Freshwater Limestone No. 13 | 1 | Stubenthal, Wurtmbu'g | | |
| 914 | " | " | Tegelkalk No. 14 | 1 | Frankfort-on-the-Main | | |
| 915 | " | " | Tegelkalk No. 15 | 1 | Wusenau bei Mainz. | | |
| 916 | " | " | Tripoli Slate No. 16 | 1 | Bilin, Bohemia | | |
| 917 | " | " | Tile or Brick Earth No. 17 | 1 | Near Vienna | | |
| 918 | " | " | Calcaire Grossier No. 18 | | Vangirard, France | | |
| 919 | " | " | Klebschiefer No. 19 | | Montmartre, France | | |
| 920 | " | " | Gypsum No. 20 | | Montmartre, France | | |
| 921 | " | " | Flysch No. 21 | | Bern, Switzerland | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|---|
| 922 | Nov. 1876 | Geo. F. Kuntz | Nummulitic Limestone | No. 22 | 1 | Kressenberg, Bavaria | | |
| 923 | " | " | Foraminifera Limestone | No. 23 | | Bavaria | | |
| 924 | " | " | Upper Chalk | No. 24 | | Maestricht, Holland | | |
| 925 | " | " | Chalk | No. 25 | | Denmark | | |
| 926 | " | " | Limestone | No. 26 | | Gossau Alps, Austria | | |
| 927 | " | " | Glanconitic Chalk | No. 27 | | Rouen, France | | |
| 928 | " | " | "Planer" Limestone | No. 28 | | Teplitz, Bohemia | | |
| 929 | " | " | "Quader" Sandstone | No. 29 | | Pyrna, Saxony | | |
| 930 | " | " | Gault | No. 30 | | Gyl Evegne, France | | |
| 931 | " | " | Wælderthon | No. 31 | | Niederschœna, Saxony | | |
| 932 | " | " | Wælderthon | No. 32 | | Santel | | |
| 933 | " | " | Hastings Sandstone | No. 33 | | Bredenbeck | | |
| 934 | " | " | Lithographic Slate | No. 34 | 1 | Solenhofen, Bavaria | | |
| 935 | " | " | Coralline Limestone | No. 35 | 1 | Istein, Baden | | |
| 936 | " | " | Jura Limestone | No. 36 | 1 | Kandern, Baden | | |
| 937 | " | " | Oxford Clay | No. 37 | 1 | Dives, France | | |
| 838 | " | " | Ornatenthon | No. 38 | 1 | Gommelshausen, Wurt | | |
| 939 | " | " | Cornbrash | No. 39 | | Vœgesheim, Baden | | |
| 940 | " | " | Oolitic Limestone | No. 40 | | Kandern, Baden | | |
| 941 | " | " | Clay Ironstone | No. 41 | | Wurtemberg | | |
| 942 | " | " | Lias Slate | No. 42 | | Boll, Wurt | Lias | |
| 943 | " | " | Lias Marl | No. 43 | | Kulmbach, Bavaria | " | |
| 944 | " | " | Lias Limestone | No. 44 | | Malsch, Baden | " | |
| 945 | " | " | Lias Sandstone | No. 45 | | Wurtemburg | " | |
| 946 | " | " | Slate | No. 46 | | St. Cassian, Tyrol | | |
| 947 | " | " | Limestone | No. 47 | | Aussee, Styria | | |
| 948 | " | " | Upper Keuper Sandstone | No. 48 | | Degernloch, Wurtem | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. | | Name. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 949 | Nov. 1876 | Geo. F. Kunz | Middle Keuper Sandstone No. 49 | 1 | Heilbronn, Wurt | | |
| 950 | " | " | Keuper Marl No. 50 | 1 | Malsch, Baden | | |
| 951 | " | Geol. Sur | Sandstone No. 51 | 1 | Sinsheim, Baden | | |
| 952 | " | " | Slate No. 52 | 1 | Sinsheim, Baden | | |
| 953 | " | " | "Muschelkalk" No. 53 | 1 | Wiesloch, Baden | | |
| 954 | " | " | Lower "Muschelkalk" No. 54 | 1 | Mostroh | | |
| 955 | " | " | "Bunter" Sandstone No. 55 | 1 | Heidelberg | | |
| 956 | " | " | Sandstone No. 56 | 1 | Kaiserslautern | | |
| 954 | " | " | Permian Gypsum No. 57 | 1 | Ihlfeld, Harz | Permian | |
| 958 | " | " | "Nechstein" No. 58 | 1 | Ilmenau, Thuringia | | |
| 959 | " | " | Permian Dolomite No. 59 | 1 | Eisleben, Thuringia | Permian | |
| 960 | " | " | Copper Slate No. 60 | 1 | Rieschelsdorf, Hessia | | |
| 961 | " | " | Permian "(Todtliegendes") No. 61 | 1 | Baden | Permian | |
| 962 | " | " | Coal Slate No. 62 | 1 | Saarbrucken | Carb | |
| 963 | " | " | Cannel Coal No. 63 | 1 | Wigan, Lancashire | " | |
| 964 | " | " | Carboniferous Sandstone No. 64 | 1 | Zwickau, Saxony | " | |
| 965 | " | " | Carboniferous Sandstone No. 65 | 1 | Le Fay, France | " | |
| 966 | " | " | Carboniferous Limestone No. 66 | 1 | Tournay, France | " | |
| 967 | " | " | Devonian Limestone No. 67 | 1 | Oberscheld, Nassau | Devonian | |
| 968 | " | " | Devonian Limestone No. 68 | 1 | Hof, Bavaria | " | |
| 969 | " | " | Gray Wacke No 69 | 1 | Ober Lahnstein | | |
| 970 | " | " | Clay Slate No. 70 | 1 | Kaub on the Rhine | | |
| 971 | " | " | Silurian Limestone No. 71 | 1 | Prague, Bohemia | Silurian | |
| 972 | " | " | Silurian Limestone No. 72 | 1 | Prague, Bohemia | " | |
| 973 | " | " | Slate No. 73 | 1 | Hof, Bavaria | | |
| 974 | " | " | Gneiss No. 74 | 1 | Freiberg, Saxony | | |
| 975 | " | " | Mica Slate No. 75 | 1 | Gadernheim, Hessia | | |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained — When. | Obtained — Whence. | NAME. | | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|---|
| 976 | Nov., 1876 | Geo. F. Kunz | Talcose Slate | No 76 | 1 | Kolmbach | | |
| 977 | " | " | Granular Limestone | No 77 | 1 | Auerbach | | |
| 978 | " | " | Granite | No 78 | 1 | Schlierbach | | |
| 979 | " | " | Graphic Granite | No 79 | 1 | Zwiesel, Bavaria | | |
| 980 | " | " | Syenite | No 80 | 1 | Reichenbach | | |
| 981 | " | " | Hornblende Rock | No 81 | 1 | Schriesheim, Baden | | |
| 982 | " | " | Eclogite | No 82 | 1 | Silberbach | | |
| 983 | " | " | Diorite | No 83 | 1 | Dillenberg, Nassau | | |
| 984 | " | " | Aphanite | No 84 | 1 | Sechshelden, Nassau | | |
| 985 | " | " | Spilite | No 85 | 1 | Limburg | | |
| 986 | " | " | Serpentine | No 86 | 1 | Kupferberg, Bavaria | | |
| 987 | " | " | Gabbro | No 87 | 1 | Wurlitz | | |
| 988 | " | " | Porphyry | No 88 | 1 | Ziegelhausen, Baden | | |
| 989 | " | " | Melaphyre | No 89 | 1 | Ilmenau, Thuringia | | |
| 990 | " | " | Basalt | No 90 | 1 | Auerbach, Hessia | | |
| 991 | " | " | Dolerite | No 91 | 1 | Katzenbuckel | | |
| 992 | " | " | Amygdaloidal Dolerite | No 92 | 1 | Sasbach, Baden | | |
| 993 | " | " | Phonolyte | No 93 | 1 | Rhoengebirge | | |
| 994 | " | " | Trachyte | No 94 | 1 | Stenzelberg, Siebengebirge | | |
| 995 | " | " | Sanidine Trachyte | No 95 | 1 | Drachenfels | | |
| 996 | " | " | Trachyte Conglomerate | No 96 | 1 | Ober Dollendorf, Rhine | | |
| 997 | " | " | Trass | No 97 | 1 | Brohl | | |
| 998 | " | " | Pitchstone | No 98 | 1 | Meissen, Saxony | | |
| 999 | " | " | Obsidian | No 99 | 1 | Lipari Isles | | |
| 1000 | " | " | Lava | No. 100 | 1 | Mt Vesuvius, Italy | | |
| 1001 | " | " | Calamine | | 178 | Ogdensburg, N. Y. | | |
| 1002 | " | " | Calamine and Smithsonite | | 5 | " | | |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1003 | Nov. 1876 | Geo. F. Kunz | Calamine | 1 | Franklin, N. J | | |
| 1004 | " | " | Natrolite | 96 | Bergen Hill, N. J | | |
| 1005 | " | " | Datolite | 138 | " | | |
| 1006 | " | " | Calcite resembling Datolite | 1 | " | | |
| 1007 | " | " | Calcite (modified) | 5 | " | | |
| 1008 | " | " | Calcite. | 78 | " | | |
| 1009 | " | " | Calcite. | 11 | Franklin, N. J | | |
| 1010 | " | " | Mesolite | 10 | Bergen Hill, N. J | | |
| 1011 | " | " | Datolite and compact Mesolite | 2 | " | | |
| 1012 | " | " | Compact Mesolite | 1 | " | | |
| 1013 | " | " | Mesolite and Datolite | 1 | " | | |
| 1014 | " | " | Peculiar form of Calcite | 1 | " | | |
| 1015 | " | " | Tabular Calcite | 5 | " | | |
| 1016 | " | " | Natrolite, Analcite and Prehnite | 1 | " | | |
| 1017 | " | " | Thomsonite | 1 | " | | |
| 1018 | " | " | Smithonite | 7 | Franklin, N. J | | |
| 1019 | " | " | Quartz | 30 | Hot Springs, Ark | | |
| 1020 | " | " | Sussexite | 1 | Franklin, N. J | | |
| 1021 | " | " | Seyberlite | 1 | Amity, N. Y | | |
| 1022 | " | " | Datolite and Pyrite | 2 | Bergen Hill, N. J | | |
| 1023 | " | " | Willemite (Troostite) | 109 | Franklin, N. J | | |
| 1024 | " | " | Zincite (Ruby) | 31 | " | | |
| 1025 | " | " | Amphibole (Hornblende) | 135 | " | | |
| 1026 | " | " | Brown Tourmaline | 1 | " | | |
| 1027 | " | " | Yellow Stilbite | 1 | Bergen Hill, N. J | | |
| 1028 | " | " | Sphalerite (Compact Blende) | 4 | Bethlehem, Pa | | Peculiar to locality |
| 1929 | " | " | Sphalerite (Blende) | 36 | Franklin, N. J | | |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1030 | Nov. 1876 | Geo. F. Kunz | Biotite (Black Iron Mica) | 1 | Franklin, N. J | | |
| 1031 | " | " | Spartaite | 5 | " | | |
| 1032 | " | " | Egyptian Marble | 1 | Italy | | |
| 1033 | " | " | Chalcopyrite | 1 | Queensland | | |
| 1034 | " | " | Cassiterite | 1 | New South Wales | | |
| 1035 | " | " | Hydraulic Cement (Rock) | 1 | Rondout, N. Y | | |
| 1036 | " | " | Franklinite | 9 | Franklin, N. J | | |
| 1037 | " | " | Sphalerite (Compact Blende) | 2 | Bethlehem, Pa | | Peculiar variety, only found here |
| 1038 | " | " | Compact Thomsonite | 1 | Bergen Hill, N.J | | |
| 1039 | " | " | Willemite and Thomsonite | 1 | Franklin, N. J | | |
| 1040 | " | " | Pectolite | 175 | Bergin Hill, N. J | | |
| 1041 | " | " | Mountain Paper | 1 | West Chester Co., N. Y | | |
| 1042 | " | " | Brown Garnet | 119 | Franklin, N. J | | |
| 1043 | " | " | Brown Garnet | 1 | " | | The rest Wellemite (Troostite) and perhaps Pyroxene (Jeff.) |
| 1044 | " | " | Zincite | 53 | " | | |
| 1045 | " | " | Quartz (Chert) in Schoharie grit | 1 | Schoharie, N. Y | | |
| 1046 | " | " | Phlogopite | 27 | Franklin, N. J | | Transparent through the sides |
| 1047 | " | " | Franklinite | 273 | " | | |
| 1048 | " | " | Willemite | 157 | " | | |
| 1049 | " | " | Franklinite and Zincite | 180 | " | | |
| 1050 | " | " | Zincite (with Calcite) | 49 | " | | |
| 1051 | " | " | Pyroxene | 88 | " | | |
| 1052 | " | " | Chalcopyrite | 4 | " | | |
| 1053 | " | " | Gahnite (Dysluite) | 50 | " | | |
| 1054 | " | " | Graphite | 100 | New York | | |
| 1055 | " | " | Tourmaline (Green) | 34 | Franklin, N. J | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1056 | Nov. 1876 | Geo. F. Kunz | Talc | 12 | Franklin, N. J | | |
| 1057 | " | " | Serpentine (Precious Serpentine) | 3 | Montville, N. J | | |
| 1058 | " | " | Calcite | 3 | Franklin, N. J | | |
| 1059 | " | " | Apatite | 18 | " | | |
| 1060 | " | " | Zincite and Willemite | 3 | " | | |
| 1061 | " | " | Lepidomelane | 9 | " | | |
| 1062 | " | " | Willemite, Franklinite and Zincite | 8 | " | | |
| 1063 | " | " | Sussexite, Zincite and Franklinite | 1 | " | | |
| 1064 | " | " | Franklinite, Zincite, Rhodochrosite (Dialogite) and Tephroite | 1 | " | | |
| 1065 | " | " | Red and Green Corundum, Chondrodite | 2 | " | | |
| 1066 | " | " | Garnet (Essonite) | 1 | " | | |
| 1067 | " | " | Pyroxene and Amphibole (Pargasite) | 2 | " | | |
| 1068 | " | " | Gahnite (Dysluite) and Garnet | 3 | " | | |
| 1069 | " | " | Spinel | 9 | " | | |
| 1070 | " | " | Chondrodite | 8 | " | | |
| 1071 | " | " | Chondrodite and Fluorite | 2 | " | | |
| 1072 | " | " | Epidote | 5 | " | | |
| 1073 | " | " | Willemite (Troostite) and Franklinite | 1 | " | | |
| 1074 | " | " | Pyroxene (Jeffersonite) and Apatite | 1 | " | | |
| 1075 | " | " | Amphibole (Hornblende) and Titanite (Sphene) | 30 | " | | |
| 1076 | " | " | Yellow Calcite | 4 | " | | |
| 1077 | " | " | Black Garnet | 35 | " | | |
| 1078 | " | " | Pyroxene (Jeffersonite) | 44 | " | | |
| 1079 | " | " | Calcite (Stalactite) | 1 | Durham Cave, 10 mi. below Easton, Pa. | | |
| 1080 | " | " | Native Copper | 9 | Lake Superior | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1081 | Nov. 1876 | Geo. F. Knnz | Garnet (Colophonite) and Franklinite | 2 | Franklin, N. J | | |
| 1082 | " | " | Garnet, (Colophonite) Franklinite & Willemite. | 1 | " | | |
| 1083 | " | " | Garnet, (Colophonite) | 7 | " | | |
| 1084 | " | " | Pyroxene (Jeffersonite) and Garnet | 3 | " | | |
| 1085 | " | " | Garnet, var. Melanite | 75 | " | | |
| 1086 | " | " | Corundum (Sapphire) | 1 | " | | |
| 1087 | " | " | Azurite | 2 | Chili | | |
| 1088 | " | " | Iridescent Datolite | 2 | Bergen Hill, N. J | | Very rare |
| 1089 | " | " | Prehnite | 39 | " | | |
| 1090 | " | " | Feldspar | 52 | Turin, N. Y | | |
| 1091 | " | " | Ruby Corundum | 2 | Franklin, N. J | | |
| 1092 | " | " | Gold | 2 | North Carolina | | |
| 1093 | " | " | Gold Quartz | 3 | California | | |
| 1094 | " | " | Calcite | 1 | England | | |
| 1095 | " | " | Pyromorphite (Brown Lead Ore) | 1 | Ems, Germany | | |
| 1096 | " | " | Millerite | 2 | Gap Mimes, Pa | | |
| 1097 | " | " | Pyrite | 1 | Roxbury, Ct | | |
| 1098 | " | " | Surpentine (Chrysotile) | 1 | Montville, N. J | | |
| 1099 | " | " | Talcose Slate | 1 | Staten Island | | |
| 1100 | " | " | Rensselærite | 3 | St. Lawrence Co., N. Y | | |
| 1101 | " | " | Amphibole (Asbestus) | 2 | Baltimore, Md | | |
| 1102 | " | " | Amphibole (Hornblende) | 1 | Amity, N. Y | | |
| 1103 | " | " | Apophyllite and Laumontite | 2 | Bergen Hill, N. J | | |
| 1104 | " | " | Fontainebleau Sandstone | 1 | Europe | | Concretions |
| 1105 | " | " | Millerite, Hematite (Specular Iron) & Siderite | 1 | Antwerp, N. J | | |
| 1106 | " | " | Calamine in Sphalerite (Blende) | 2 | Granby, Mo | | |
| 1107 | " | " | Fibrous Red Hematite | 1 | Maryland | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—**Continued.**

| No. | Obtained — When | Obtained — Whence | NAME. | No. of Specimens. | Locality | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1108 | [illegible] | Geo. F. Kunz | Blue Corundum | 1 | Franklin, N. J. | | |
| 1109 | | " | Staurolite | 1 | Georgia | | |
| 1110 | " | " | Serpentine (Baltimorite) | 1 | Wood mine, Texas, Lancaster Co., Pa. | | |
| 1111 | " | " | Anthophyllite | 1 | Wood mine, Texas, Lancaster Co., Pa. | | |
| 1112 | " | " | Black Garnet | 2 | Franklin, N. J. | | |
| 1113 | " | " | Brown Garnet and Epidote | 4 | " | | |
| 1114 | " | " | Aluminite (Hallite) | 5 | Texas, Pa. | | |
| 1115 | " | " | Grey Tephroite and Zincite | 1 | Franklin, N. J. | | |
| 1116 | " | " | Hematite (Specular Iron) | 1 | Island of Elba | | |
| 1117 | " | " | Magnetite | 2 | Sussex Co., N. Y. | | |
| 1118 | " | " | Rutile (Rutilated Quartz) | 1 | Switzerland | | |
| 1119 | " | " | Pinite (Agalmatolite) | 1 | China | | |
| 1120 | " | " | Pent. Dodec Pyrite | 11 | New Jersey | | |
| 1121 | " | " | Corundum | 4 | Franklin, N. J. | | |
| 1122 | " | " | Cuprite | 1 | Valparaizo, Chili | | |
| 1123 | " | " | Prehnite and Natrolite | 4 | Bergen Hill, N. J. | | |
| 1124 | " | " | Silver and Gold in Pyrite, Galenite (Galena) | 1 | California | | |
| 1125 | " | " | Pyrite | 40 | Franklin, N. J. | | |
| 1126 | " | " | "Greenish Mica" | 2 | Connecticut | | |
| 1127 | " | " | Millerite | 3 | Antwerp, N. Y. | | |
| 1128 | " | " | Phlogopite | 6 | St. Lawrence Co., N. Y. | | |
| 1129 | " | " | Vesuvianite (Idocrase) | 5 | Amity, N. Y. | | |
| 1130 | " | " | Brookite | 1 | Ellenville, N. Y. | | Translucent yellow on quartz. |
| 1131 | " | " | Stilbite | 2 | Poorah, Hindostan | | |
| 1132 | " | " | Datolite and Natrolite | 11 | Bergen Hill, N. J. | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1133 | Nov. 1876 | Geo. F. Kunz | Datolite and Stilbite | 2 | Bergen Hill, N.J | | |
| 1134 | " | " | Apophyllite | 67 | " | | |
| 1135 | " | " | Calcite and Stilbite | 5 | " | | |
| 1136 | " | " | Quartz and Limonite, | 1 | Hoboken, N. J. | | |
| 1137 | " | " | Stilbite | 6 | New York City | | |
| 1138 | " | " | Calcite and Pyrite | 11 | Bergen Hill, N. J | | |
| 1139 | " | " | Epidote | 12 | Franklin, N. J | | |
| 1140 | " | " | Quartzite Conglomerate., | 1 | Morristown, N. Y. | | |
| 1141 | " | " | Crystalline Furnace Slag | 1 | Easton, Pa | | |
| 1142 | " | " | Smithsonite | 4 | Franklin, N. J | | |
| 1143 | " | " | Limonite and Gœthite (Lepidokrokite) | 2 | Chestnut Hill, Pa | | |
| 1144 | " | " | Chabazite | 1 | New York City | | |
| 1145 | " | " | Quartz | 1 | Dauphiney, France | | |
| 1146 | " | " | Zincite and Tephroite | 9 | Franklin, N. J | | |
| 1147 | " | " | Franklinite and Tephroite | 9 | " | | |
| 1148 | " | " | Franklinite, Zincite and Tephroite | 16 | " | | |
| 1149 | " | " | Franklinite, Zincite and Rhodonite | 1 | " | | |
| 1150 | " | " | Calcite and Analcite | 7 | Bergen Hill, N.J | | |
| 1151 | " | " | Witherite | 6 | England | | |
| 1152 | " | " | Magnesite, compact | 7 | Hoboken, N. J. | | |
| 1153 | " | " | Dolomite (Pearl Spar) | 4 | Lockport, N. Y | Niagara | |
| 1154 | " | " | Dolomite(Pearl Sp'r)and Calcite (DogTooth Sp'r | 1 | " | | |
| 1155 | " | " | Serpentine | 2 | Gouverneur, N, Y | | |
| 1156 | " | " | Sussexite, Ruby Zincite and Rhodochrosite (Dia. | 1 | Franklin, N. J | | |
| 1157 | " | " | Herschelite and Gismondite in Trachyte | 1 | Cyclopean Islands | | |
| 1158 | " | " | Slickensides | 3 | Franklin, N. J | | |
| 1159 | " | " | Pectolite and Prehnite | 3 | Bergen Hill, N.J | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| No. | Obtained: When | Obtained: Whence | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1160 | [illegible] | Geo. F. Kunz | Stilbite | 17 | Bergen Hill, N.J | | |
| 1161 | " | " | Sphalerite (Blende) | 4 | Missouri | | |
| 1162 | " | " | Calcite (Dog Tooth Spar) | 3 | Lockport, N. Y | | |
| 1163 | " | " | Spinel and Chondrodite | 3 | Franklin, N. J | | |
| 1164 | " | " | Ophiolyte | 1 | New York City | | |
| 1165 | " | " | Datolite and Calcite | 3 | Bergen Hill, N.J | | |
| 1166 | " | " | Prehnite and Sphalerite (Blende) | 1 | " | | |
| 1167 | " | " | Prehnite, Gmelinite and Blende | 5 | " | | |
| 1168 | " | " | Ægirite | 14 | Near Magnet Cove, Ark | | |
| 1169 | " | " | Chrysocolla | 1 | Maryland | | |
| 1170 | " | " | Chrysocolla and Atacamite | 1 | " | | |
| 1171 | " | " | Wulfenite and Pyromorphite | 3 | Southampton, Mass | | |
| 1172 | " | " | Limonite | 10 | Staten Island | | |
| 1173 | " | " | Quartz (Silicified Wood) | 1 | Colorado | | |
| 1174 | " | " | Feldspar and Ægirite | 1 | Near Magnet Cove, Ark | | |
| 1175 | " | " | Trap Crystals | 2 | Bergen Hill, N.J | | |
| 1176 | " | " | Chalcopyrite | 8 | Tennessee | | 1 |
| 1177 | " | " | Quartz (Moss agate) | 5 | Cheyenne, W. T | | |
| 1178 | " | " | Copalite (Copal) | 4 | Zanzibar, Africa | | |
| 1179 | " | " | Quartz (Smoky) | 5 | Colorado (Pikes Peak) | | |
| 1180 | " | " | Quartz (Chalcedony) | 2 | Germany | | |
| 1181 | " | " | Quartz (Agate) | 2 | " | | With fine design |
| 1182 | " | " | Quartz (Jasper) | 1 | " | | |
| 1183 | " | " | Quartz (Agate) | 1 | | | |
| 1184 | " | " | Quartz (Onyx) | 1 | Oberstein, Germany | | |
| 1185 | " | " | Quartz (Agate) | 1 | Oberstein, Germany | | |
| 1186 | " | " | Smoky Quartz | 10 | Magnet Cove, Ark | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1187 | Nov. 1876 | Geo. F. Kunz | Manganite | 7 | Nova Scotia | | |
| 1188 | " | " | Sphalerite (Blende) and Pyrite | 1 | Pike's Peak, Col | | Blende resembles Galena |
| 1189 | " | " | Magnetite | 4 | Nova Scotia | | |
| 1190 | " | " | Beryl | 1 | Connecticut | | |
| 1191 | " | " | Feldspar | 1 | New York City | | |
| 1192 | " | " | Serpentine with Chromite | 1 | Hoboken, N. J | | |
| 1193 | " | " | Magnetite | 2 | Port Henry | | |
| 1194 | " | " | Siderite and Gneiss | 1 | New York City | | |
| 1195 | " | " | Ægirite on Orthoclase (Feldspar) | 1 | Near Magnet Cave, Ark. | | |
| 1196 | " | " | Talc | 1 | Staten Island | | |
| 1197 | " | " | Orthoclase | 7 | New York City | | |
| 1198 | " | " | Apophyllite and Analcite | 3 | Bergen Hill, N. J | | |
| 1199 | " | " | Apophyllite and Prehnite | 2 | " | | |
| 1200 | " | " | Magnesite in Cerolite | 6 | Hoboken, N. J | | |
| 1201 | " | " | Magnesite | 1 | " | | |
| 1202 | " | " | Datolite. White | 2 | Bergen Hill, N. J | | |
| 1203 | " | " | Analcite | 12 | " | | |
| 1204 | " | " | Datolite and Natrolite | 2 | " | | |
| 1205 | " | " | Natrolite and Analcite | 2 | " | | Large cryst. for loc. |
| 1206 | " | " | Apophylite and Gmelinite | 1 | " | | |
| 1207 | " | " | Datolite and Gmelinite | 3 | " | | |
| 1208 | " | " | Natrolite and Apophyllite | 2 | " | | |
| 1209 | " | " | Orthoclase (Adularia) | 1 | Windsor, Mass | | |
| 1210 | " | " | Brown Harmotome | 1 | Hudson, N. Y | | |
| 1211 | " | " | Shell Limestone | 1 | " | | |
| 1212 | " | " | Graphite (Picture Mica) | 1 | Lancaster Co., Pa | | |
| 1213 | " | " | Pyrrhotite | 4 | St. Anthony's Nose, N. Y. | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. | | NAME. | No. of Specimen. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1214 | Nov. 1876 | Geo. F. Kunz | Chalcopyrite | 7 | Vermont | | |
| 1215 | " | " | Chalcopyrite | 2 | Cuba | | |
| 1216 | " | " | Pectolite | 4 | Bergen Hill, N. J | | Odd form |
| 1217 | " | " | Calcite | 1 | Unknown | | |
| 1218 | " | " | Slag | 4 | From Furnace near Easton, Pa. | | |
| 1219 | " | " | "From Iron Furnace" | 1 | Northern New York | | |
| 1220 | " | " | Mica | 4 | Franklin, N. J | | |
| 1221 | " | " | Natrolite and Stilbite | 2 | Bergen Hill, N. J | | |
| 1222 | " | " | Thomsonite | 5 | " | | |
| 1223 | " | " | Quartz | 1 | Hoboken, N. J | | |
| 1224 | " | " | Garnet (Melanite) | 1 | Franklin, N. J | | |
| 1225 | " | " | Opal | 2 | Honduras | | |
| 1226 | " | " | Rhodonite (Crystals of Fowlerite) | 1 | Franklin, N. J | | |
| 1227 | " | " | Pyrolusite | 1 | Germany | | |
| 1228 | " | " | Pumice | 2 | " | | |
| 1229 | " | " | Pyrite | 6 | Kentucky | | |
| 1230 | " | " | Datolite and Analcite | 2 | Bergen Hill, N. J | | |
| 1231 | " | " | Datolite, Natrolite and Prehnite | 1 | " | | |
| 1232 | " | " | Barite | 13 | Cheshire, Ct | | |
| 1233 | " | " | Calamine | 1 | Franklin, N. J | | |
| 1234 | " | " | Aurichalcite (Green Calamine) | 2 | Ogdensburg, N. Y | | |
| 1235 | " | " | Willemite (Troostite) and Franklinite | 2 | Franklin, N. J | | |
| 1236 | " | " | Serpentine | 6 | Hoboken, N. J | | |
| 1237 | " | " | Hematite (Specular Iron) after Franklinite | 1 | Franklin, N. J | | |
| 1238 | " | " | Brucite | 2 | Hoboken, N. J | | |
| 1239 | " | " | Hydromagnesite | 5 | " | | |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Seiral Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1240 | Nov. 1876 | Geo. F. Kunz | Ægirite with Nephelite, (Elæolite) | 6 | Magnet Cave, Ark | | |
| 1241 | " | " | Rutile (Nigrine) | 38 | " | | |
| 1242 | " | " | Phosphatic Nodule | 5 | Charleston, S. C. | | |
| 1243 | " | " | Wulfenite and Pyromorphite | 5 | Southampton, Mass. | | |
| 1244 | " | " | Quartz (Itacolumite) | 7 | North Carolina | | |
| 1245 | " | " | Dolomite | 3 | Westchester Co., N. Y. | | |
| 1246 | " | " | Chromite | 1 | Texas, Pa. | | |
| 1247 | " | " | Tourmaline | 1 | Delaware Co., Pa. | | Detached |
| 1248 | " | " | Columbite | 4 | New Alstead, N. H. | | |
| 1249 | " | " | Sussexite and Tephroite | 1 | Franklin, N. J. | | |
| 1250 | " | " | Cerussite and Pyromorphite | 1 | Phœnixville, Pa. | | |
| 1251 | " | " | Franklinite and Willemite | 10 | Franklin, N. J. | | |
| 1252 | " | " | Greenockite on Sphalerite (Blende) | 2 | Granby, Mo. | | |
| 1253 | " | " | Barite and Pyrite | 1 | Scales Mound, Ill. | | |
| 1254 | " | " | Brown Tourmaline | 30 | New York City | | |
| 1255 | " | " | Psilomelane and Pyrolusite | 2 | Northern New York | | |
| 1256 | " | " | Stibnite, Artificial | 2 | Hungary | | |
| 1257 | " | " | Corundum | 1 | North Carolina | | |
| 1258 | " | " | Aragonite | 1 | Unknown | | |
| 1259 | " | " | Chabazite (Acadialite) | 1 | Nova Scotia | | |
| 1260 | " | " | Dufrenite | 2 | Monmouth Co., N. J. | | |
| 1261 | " | " | Mineral Coal (Lignite) | 5 | England | | |
| 1262 | " | " | Fossiliferous Hematite | 1 | Clinton, N. Y. | | |
| 1263 | " | " | Magnetite | 1 | Unkown | | |
| 1264 | " | " | Radiated Gypsum | 1 | Nova Scotia | | |
| 1265 | " | " | Barite | 2 | Scales Mound, Ill. | | |
| 1266 | " | " | Penninite (Kammererite) | 3 | Lancaster Co., Pa. | | |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1267 | Nov. 1876 | Geo. F. Kunz | Brookite (Arkansite) on Quartz | 7 | Magnet Cave, Ark | | |
| 1268 | " | " | Brookite on Quartz | 4 | " | | |
| 1269 | " | " | Willemite (Williamsite) | 1 | Texas, Pa | | |
| 1270 | " | " | Fluorite | 8 | Franklin, N. J | | |
| 1271 | " | " | Apatite | 1 | Rossie, N. Y | | |
| 1272 | " | " | Smithsonite | 2 | Bethlehem, Pa | | |
| 1273 | " | " | Ripidolite (Clinochlore) | 1 | Texas, Pa | | |
| 1274 | " | " | Sphalerite (Cleiophane) | 4 | Franklin, N. J | | |
| 1275 | " | " | Limonite (Bog Iron) | 1 | New York | | |
| 1276 | " | " | Deweylite | 1 | Texas, Pa | | |
| 1277 | " | " | Red Hematite | 4 | Nova Scotia | | |
| 1278 | " | " | Amphibole (Hornblende) and Fluorite (Fluor) | 1 | Franklin, N. J | | |
| 1279 | " | " | Amphibole (Hornblende) and Apatite | 1 | " | | |
| 1280 | " | " | Talcose Slate | 1 | Staten Island | | |
| 1281 | " | " | Gypsum | 1 | Cape Breton, N. Scotia | | |
| 1282 | " | " | Sphalerite (Blende) and Greenockite | 1 | Granby, Mo | | |
| 1283 | " | " | Calcite, Epidote and Copper | 1 | Lake Superior | | |
| 1284 | " | " | Greenockite and Asphaltum (Bitumen) on Pyrargyrite (Ruby-Blende) | 1 | Oronogo, Mo | | |
| 1285 | " | " | Sphalerite (Ruby Zinc-Blende) | 4 | " | | |
| 1286 | " | " | Gypsum (Selenite) | 3 | Nova Scotia | | |
| 1287 | " | " | Smithsonite on Calamine | 1 | Granby, Mo | | |
| 1288 | " | " | Siderite | 1 | New York City | | |
| 1289 | " | " | Galenite (Galena) | 2 | Missouri | | Peculiar Crystals |
| 1290 | " | " | Galenite, (Galena) Feathery | 1 | " | | |
| 1291 | " | " | Wulfenite | 6 | Southampton, Mass | | |
| 1292 | " | " | Regalar | 3 | Turkey | | |

*Catalogue of Specimens Rigistered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. | | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1293 | Nov. 1876 | Geo. F. Kunz | Cyanite | 1 | Pennsylvania | | 27 |
| 1294 | " | " | Stilbite (Sphærostilbite) | 2 | Bergen Hill, N.J | | Very rare |
| 1295 | " | " | Titanite (Sphene var Lederite) | 1 | Franklin, N. J | | |
| 1296 | " | " | Wernerite (Scapolite) | 16 | Franklin, N. J | | |
| 1297 | " | " | Tourmaline | 1 | Lambertville, Pa | | |
| 1298 | " | " | Psilomelane | 2 | Hot Springs, Ark | | |
| 1299 | " | " | "Pipe Ore" | 2 | Kentucky | | |
| 1300 | " | " | Melaconite (Tenorite) and Calcite | 1 | Unknown | | |
| 1301 | " | " | Zincite (Crystals of yellow Oxyde of Zinc) | 1 | Franklin, N. J | | "From fused ore heaps." |
| 1302 | " | " | Psilomelane | 2 | Virginia | | |
| 1303 | " | " | Molybdenite | 1 | Haddam, Conn | | |
| 1304 | " | " | Ripidolite (Clinochlore) | 4 | Lancaster Co., Pa | | |
| 1305 | " | " | Atacamite | 2 | Atacama, Chili | | |
| 1306 | " | " | Prehnite, Thomsonite and Laumontite | 1 | Bergen Hill, N.J | | |
| 1307 | " | " | Dioryte | 1 | " | | |
| 1308 | " | " | Mineral Coal (Lignite) | 1 | Alaska | | |
| 1309 | " | " | Azurite | 1 | Chili, S. A | | |
| 1310 | " | " | Spodumene | 1 | Franklin, N. J | | |
| 1311 | " | " | Amphibole (Tremolite) | 1 | Lewis Co., N. Y | | |
| 1312 | " | " | Chalcocite | 2 | Bristol, Conn | | |
| 1313 | " | " | Hypersthene | 3 | Lewis Co., N. Y | | |
| 1314 | " | " | Ferruginous Quartz | 5 | Brooklyn, N. Y | Drift | |
| 1315 | " | " | Siderite | 1 | Easton, Pa | | |
| 1316 | " | " | Talc (Steatite Pseudo after Pyroxene) | 4 | Franklin, N. J | | |
| 1317 | " | " | Cacoxenite | 1 | Antwerp, N. Y | | |
| 1318 | " | " | Zaratite | 4 | Texas, Pa | | |
| 1319 | " | " | Amphibole (Hornblende) and Graphite | 1 | Amity, N. Y | | |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1320 | Nov. 1876 | Geo. F. Kunz | Uraconite (Uranochre) | 1 | St. Just, Scotland | | |
| 1321 | " | " | Anglesite | 1 | Phœnixville, Pa. | | |
| 1322 | " | " | Hypersthene and Pyrite | 1 | Franklin, N. J | | |
| 1323 | " | " | Amphibole (Hornblende) and Apatite | 1 | " | | |
| 1324 | " | " | "Silver Mica" | 1 | " | | |
| 1325 | " | " | Schorlomite | 9 | Magnet Cove, Ark | | |
| 1326 | " | " | Garnet | 1 | Franklin, N. J | | |
| 1327 | " | " | Quartz | 10 | " | | |
| 1328 | " | " | Tourmaline | 8 | " | | |
| 1329 | " | " | Hypersthene | 1 | " | | |
| 1330 | " | " | Seybertite | 2 | " | | |
| 1331 | " | " | Talc (Steatite, Pseudo, after some mineral) | 1 | " | | |
| 1332 | " | " | Slickensides on White Topaz | 1 | " | | |
| 1333 | " | " | Talc (Steatite on Graphite) | 1 | " | | |
| 1334 | " | " | Phlogopite | 2 | Sterling, N. Y | | |
| 1335 | " | " | Tourmaline | 2 | New York City | | |
| 1336 | " | " | Garnet (Melanite) containing Schorlomite | 4 | Magnet Cove, Ark | | |
| 1337 | " | " | Rhodochrosite (Dialogite) | 2 | Franklin, N. J | | |
| 1338 | " | " | Willemite (Green—rare color) | 11 | " | | |
| 1339 | " | " | Dolomite (Perl Spar) in trans Gypsum (Silenite) | 1 | Lockport, N. Y | | |
| 1340 | " | " | Zincite and Dialogite | 1 | Franklin, N. J | | |
| 1341 | " | " | Niccoliferous Pyrites | 15 | " | | |
| 1342 | " | " | Franklinite and Lepidomelane (Black Mica) | 1 | " | | |
| 1343 | " | " | Chalcopyrite | 1 | California | | |
| 1344 | " | " | Sphalerite (Blende) | 117 | Oronogo, Mo | | |
| 1345 | " | " | Hematite | 1 | Antwerp, N. Y | | |
| 1346 | " | " | Quartz (Chalcedony) | 1 | Mt. Tom, Mass | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1347 | Nov. 1876 | Geo. F. Kunz | Quartz (Flint), with fossils from chalk | 1 | England | | |
| 1348 | " | " | "Lithomarge." | 1 | Bergen Hill, N. J | | |
| 1349 | " | " | Prehnite and Thomsonite | 1 | " | | |
| 1850 | " | " | Orthoclase | 1 | Dixon's Quarry, Del | | |
| 1351 | " | " | Malachite in Red Hematite | 1 | Maryland | | |
| 1352 | " | " | Stilbite | 4 | Franklin, N. J | | |
| 1353 | " | " | Brown Tourmaline | 2 | " | | |
| 1354 | " | " | Red Hematite | 1 | Staten Island | | |
| 1355 | " | " | Mineral Coal (Cannel Coal) | 2 | England | | |
| 1356 | " | " | Mineral Coal (Anthracite) | 1 | Scranton, Pa. | | |
| 1357 | " | " | Quartz | 9 | Ellenville, N. Y. | | |
| 1358 | " | " | Quartz | 1 | Switzerland | | |
| 1359 | " | " | Fluorite | 1 | Muscalonge Lake, N. Y. | | |
| 1360 | " | " | Garnet (Essonite) | 1 | New Hampshire | | |
| 1361 | " | " | Pyroxene and Amphibole (Hornblende) | 2 | Franklin, N. J | | |
| 1362 | " | " | Sphalerite (Blende) and Asphaltum (Bit'n) | 1 | Missouri | | |
| 1363 | " | " | Amphibole (Hornblende) and Graphite | 1 | Franklin, N. J | | |
| 1364 | " | " | Spinel | 1 | Hamburg, N. Y | | |
| 1365 | " | " | Gypsum (Selenite) | 1 | Nova Scotia | | |
| 1366 | " | " | Malachite | 1 | | | |
| 1367 | " | " | Chromite | 1 | California | | |
| 1368 | " | " | Serpentine | 1 | Hoboken, N. J | | |
| 1369 | " | " | Epidote | 2 | Lake Superior | | |
| 1370 | " | " | Epidote and Orthoclase | 3 | " | | |
| 1371 | " | " | Epidote and Quartz | 1 | " | | |
| 1372 | " | " | Green and Red Corundum | 1 | Franklin, N. J | | |
| 1373 | " | " | Sphalerite (Blende) and Galenite (Galena) | 3 | Oronogo, Mo | | |

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| Serial No. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1374 | Nov. 1876 | Geo. F. Kunz | Copper in Calcite with Epidote | 2 | Lake Superior | | |
| 1375 | " | " | "Spiegeleisen" | 1 | Sweden | | |
| 1376 | " | " | Magnetite | 1 | Franklin, N. J. | | |
| 1377 | " | " | Amygdaloid | 1 | Massachusetts | | |
| 1378 | " | " | Galenite in Fluorite | 2 | Galena, Ill. | | |
| 1379 | " | " | Pyrargyrite (Ruby Blende) | 3 | Oronogo, Mo. | | |
| 1380 | " | " | Siderite (Carbonate of Iron) | 1 | North Carolina | | |
| 1381 | " | " | Psilomelane | 2 | Northern New York | | |
| 1382 | " | " | Chromite and Penninite | 2 | Texas, Pa. | | |
| 1383 | " | " | Calamine and Sphalerite (Blende) | 1 | Missouri | | |
| 1384 | " | " | Calcite and Dolomite (Pearl Spar) | 1 | Lockport, N. Y. | | |
| 1385 | " | " | Quartz (Chalcedony) on Trihedral Quartz | 1 | Poorah, Hindostan | | |
| 1386 | " | " | Galenite and Pyrargyrite (Ruby Blende) | 2 | Oronogo, Mo. | | |
| 1387 | " | " | White and Red Zincite | 2 | Franklin, N. J. | | |
| 1388 | " | " | Calamine | 2 | Granby, Mo. | | |
| 1389 | " | " | Epidote and Orthoclase (Feldspar) | 9 | Lake Superior | | |
| 1390 | " | " | Galenite | 6 | Oronogo, Mo. | | |
| 1391 | " | " | Franklinite and Ruby Zincite | 2 | Franklin, N. J. | | |
| 1392 | " | " | Ferruginous Quartz | 1 | Connecticut | | |
| 1393 | " | " | Pinite (Agalmatolite) | 1 | China | | Chinese figure stone |
| 1394 | " | " | Apatite | 4 | Bob Lake, Canada | | |
| 1395 | " | " | "Kidney Ore," | 1 | Bethlehem, Pa. | | |
| 1396 | " | " | Red Hematite | 1 | Antwerp, N. Y. | | |
| 1397 | " | " | Limonite | 3 | Salisbury, Conn. | | |
| 1398 | " | " | Diaspore | 2 | Chester, Mass. | | |
| 1399 | " | " | Slag from Furnace | 1 | New York | | |
| 1400 | " | " | Cuprite | 1 | England | | |

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| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1401 | Nov. 1876 | Geo. F. Kunz | Pyrite. Pent. Dodec | 1 | Belgium | | |
| 1402 | " | " | Sulphur | 1 | Sabine, West Indies | | |
| 1403 | " | " | Native Bismuth | 1 | Connecticut | | |
| 1404 | " | " | Pyrophyllite | 1 | Deep River, N. C | | |
| 1405 | " | " | Collyrite (Dillnite) with Diaspore | 1 | Shemnitz, Hungary | | |
| 1406 | " | " | Feldspar | 1 | Desert of Sinai, Africa | | |
| 1407 | " | " | Garnet | 1 | Piedmont, Italy | | |
| 1408 | " | " | Garnet | 2 | New Town, Conn | | |
| 1409 | " | " | Garnet | 1 | Canada | | |
| 1410 | " | " | Garnet | 1 | St. Lawrence Co., N. Y | | |
| 1411 | " | " | Quartz (Chalcedony) | 1 | Poonah, Hindostan | | |
| 1412 | " | " | Beauxite | 1 | Cabasse. France | | |
| 1413 | " | " | Feldspar | 2 | Lewis County, N. Y | | |
| 1414 | " | " | "Red Ochre" | 1 | Staten Island | | |
| 1415 | " | " | Beryl | 2 | Ackworth, N. H | | |
| 1416 | " | " | Heulandite | 1 | New York City | | |
| 1417 | " | " | Serpentine (Marmolite) | 1 | Hoboken, N. Y | | |
| 1418 | " | " | Calamine | 1 | Saucon Valley, Pa | | |
| 1419 | " | " | Quartz (Chalcedony) | 1 | Florida | | |
| 1420 | " | " | Pyrite in Coal Shale | 1 | Scanton, Pa | | |
| 1421 | " | " | Hauynite (in Lava) | 1 | Anderbach, Ger | | |
| 1422 | " | " | Native Copper with Silver | 1 | Lake Superior | | Showing Silver in spots |
| 1423 | " | " | Magnetite | 2 | Nova Scotia | | |
| 1424 | " | " | Quartz (Petrified Wood) | 1 | California | | |
| 1425 | " | " | White Apatite | 1 | Santander, Spain | | |
| 1426 | " | " | Amphibole (Tremolite) | 3 | Gouverneur. N. Y | | |
| 1427 | " | " | Glauberite and Mexite, (Hayesine) | 2 | Iquique, S. A | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1428 | Nov. 1876 | Geo. F. Kunz | Aragonite | 1 | Bastennes Landes, Fr. | | |
| 1429 | " | " | Quartz (Brown Jasper) | 2 | Murphreys, Cal | | |
| 1430 | " | " | Orthoclase | 1 | Lipervillc, Pa. | | |
| 1431 | " | " | Quartz (Silicified Wood) | 1 | Nevada County, Cal | | |
| 1432 | " | " | Cerolite | 1 | Hoboken, N. J. | | |
| 1433 | " | " | Molybnite | 1 | Westmoreland. Mass | | |
| 1434 | " | " | Cyanite | 2 | Trumbull. Conn. | | |
| 1435 | " | " | Serpentine | 1 | St. Lawrence, N. Y | | |
| 1436 | " | " | Serpentine (Precious Serpentine) | 1 | Gouverneur, N. Y | | |
| 1437 | " | " | Hematite (Specular Iron) | 3 | Antwerp, N. Y. | | |
| 1438 | " | " | Sphalerite (Blende) | 1 | Ellenville, N. Y. | | |
| 1439 | " | " | Quartz containing Asphaltum (Bitumen) | 4 | Herkimer County, N. Y. | | |
| 1440 | " | " | "Hagemanite" | 1 | Ivigtut, Greenland | | |
| 1441 | " | " | Cinnabar | 1 | West California | | |
| 1442 | " | " | Cerussite | 1 | Germany | | |
| 1443 | " | " | Cerussite | 2 | Davidson County, N. C. | | |
| 1444 | " | " | Chrysolite (Olivine) in Trap | 1 | Europe | | Exact locality unknown |
| 1445 | " | " | Quartz (Calloused) | 128 | Crystal Mountains, Ark. | | |
| 1446 | " | " | Quartz | 3 | Unknown | | |
| 1447 | " | " | Quartz from Lead Mine | 1 | Southampton, Mass | | |
| 1448 | " | " | Calcite [modified] | 1 | Bergen Hill. N. J. | | |
| 1449 | " | " | Quartz (Geode) | 1 | Illinois | | |
| 1450 | " | " | Tourmaline and Smoky Quartz | 1 | New York City | | |
| 1451 | " | " | Brucite | 1 | Texas, Pa. | | |
| 1452 | " | " | Mica Crystals | 1 | Sterling, N. J. | | |
| 1453 | " | " | Calcite | 1 | Roseville, N. J. | | |
| 1454 | " | " | Flourite and Apatite | 1 | Franklin, N. J. | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1455 | Nov. 1876 | Geo. F. Kunz. | Amphibole (Byssotite) | 1 | Bergen Hill, N. J | | |
| 1456 | " | " | Calcite (Calc Tufa) | 1 | Cansted, Germany | | |
| 1457 | " | " | Porcelanite (Porcelain Jasper) | 1 | Germany | | |
| 1458 | " | " | Gmelinite | 1 | Two Islands, N. Scotia | | |
| 1459 | " | " | Quartz (Jasper) and Serpentine | 1 | Hoboken, N. J | | Point of contact between— |
| 1460 | " | " | Graphite Picture Mica | 5 | Sussex Co., N. J | | |
| 1461 | " | " | Quartz (Rose) | 1 | Franklin, N. J | | |
| 1462 | " | " | Apophyllite | 6 | Bergen Hill, N. J | | Crystals of a rare form |
| 1463 | " | " | Mica | 2 | New Hampshire | | |
| 1464 | " | " | Titanite (Sphene) | 4 | Franklin, N. J | | |
| 1465 | " | " | Titanite (Sphene) | 1 | Diana, N. Y | | |
| 1466 | " | " | Mica | 2 | New York City | | |
| 1467 | " | " | Quartz (Green Jasper) | 1 | Connecticut | | |
| 1468 | " | " | Feldspar | 1 | France | | [form |
| 1469 | " | " | Prehnite and Pectolite (crystallized) | 1 | Bergen Hill, N. J | | In separate crystals—very rare |
| 1470 | " | " | Geode of Limonite | 1 | Staten Island, N. Y | | |
| 1471 | " | " | Pyrites (radiated) | 1 | Germany | | |
| 1472 | " | " | Iridescent Limonite | 1 | Chestnut Hill, Pa | | |
| 1473 | " | " | Quartz (Amethyst) | 2 | Thunder Bay, L. S. | | |
| 1474 | " | " | Quartz | 1 | Parana, Brazil | | |
| 1475 | " | " | Quartz (in matrix) | 1 | Herkimer Co., N. Y | | In calciferous sandrock |
| 1476 | " | " | Analcite | 1 | Cyclopean Is. | | Rare form—clear and showing |
| 1477 | " | " | Rhodonite (Fowlerite crystallized) | 1 | Franklin, N. J | | [face of cube |
| 1478 | " | " | Rhodocrosite (Dialogite) | 1 | Franklin, N. J | | Contains Magnesia |
| 1479 | " | " | Pyroxene (Pargasite) | 2 | Franklin, N. J | | |
| 1480 | " | " | Calcite (Argentine) | 4 | Montville, N. J | | |
| 1481 | " | " | Quartz (Bloodstone) | 4 | Texas | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—**Continued.**

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1482 | Nov. 1876 | Geo. F. Kunz | Quartz (Rose) | 2 | Haddam, Ct. | | |
| 1483 | " | " | Rutile | 1 | Franklin, N. J. | | |
| 1484 | " | " | Serpentine (Chrysotile) | 3 | Montville, N. J. | | |
| 1485 | " | " | Compact Garnet | 1 | New York City | | |
| 1486 | " | " | Pyroxene | 1 | Lewis Co. N. Y. | | |
| 1487 | " | " | Cyanite (Rhætizite) | 1 | Germany | | |
| 1488 | " | " | Pectolite | 2 | Bergen Hill, N. J. | | Rare forms. |
| 1489 | " | " | Stilbite | 1 | Nova Scotia | | |
| 1490 | " | " | Quartz | 2 | Herkimer, Co. N. Y. | | Showing empty cavities. |
| 1491 | " | " | Muscovite | 2 | St. Lawrence, N. Y. | | |
| 1492 | " | " | Calcite | 4 | Rossie, N. Y. | | |
| 1493 | " | " | Serpentine | 3 | Montville, N. J. | | |
| 1494 | " | " | Apophyllite containing Ripidolite (Chlorite) | 1 | Bergen Hill, N. J. | | |
| 1495 | " | " | Copalite (with insects) | 2 | Zanzibar, Africa | | |
| 1496 | " | " | Pyrite (auriferous) | 1 | Queensland | | With Chalcopyrite |
| 1497 | " | " | Antimony (from Stibnite) | 1 | Victoria | | |
| 1498 | " | " | Corundum (Sapphire) | 1 | Vernon, N. J. | | |
| 1499 | " | " | Mesolite and Calcite | 4 | Bergen Hill | | |
| 1500 | " | " | Gmelinite on Datolite | 2 | Bergen Hill | | White and rare. |
| 1501 | " | " | Apophyllite and Stilbite | 1 | Bergen Hill, N. J. | | |
| 1502 | " | " | Calcite (Dog Tooth Spar) | 5 | Missouri | | |
| 1503 | " | " | "Satin Spar" | 2 | Wales | | |
| 1504 | " | " | Naumannite on Garnet | 4 | Victoria, Australia | | |
| 1505 | " | " | Pyroxene | 1 | Lewis Co, N. Y. | | |
| 1506 | " | " | Calcite (Spartaite) | 1 | Sparta, N. J. | | |
| 1507 | " | " | Red and Green Tourmaline | 2 | Minas Geras, Brazil | | |
| 1508 | " | " | Wollastonite | 1 | Near Haverstraw, N. Y. | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—**Continued.**

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1509 | Nov. 1876 | Geo. F. Kunz | Thomsenolite | 1 | Tvigtut, Greenland | | |
| 1510 | " | " | Smithsonite | 1 | Zinc Co., Mo | | |
| 1511 | " | " | Pyrite and Galenite | 1 | Rossie, N. Y | | |
| 1512 | " | " | Spinel and Corundum [gite. | 1 | Franklin, N. J | | |
| 1513 | " | " | Franklinite, Zincite and Rhodochrosite (Dialo- | 1 | Franklin, N. J | | |
| 1514 | " | " | "Scapolite" on Amphibole (Hornblende) | 1 | Franklin, N. J | | |
| 1515 | " | " | Stilbite | 2 | Southbury, Connecticut | | |
| 1516 | " | " | Green Tourmaline | 2 | Franklin, N. J | | |
| 1517 | " | " | Manganite | 1 | Franklin, N. J | | |
| 1518 | " | " | Wernerite | 2 | Lewis Co., N. Y | | |
| 1519 | " | " | Vivianite (Mullicite) | 1 | Mullica Hill, N. J | | |
| 1520 | " | " | Analcite (Analcime) | 1 | Nova Scotia | | |
| 1521 | " | " | Seybertite (Clintonite) | 3 | Franklin, N. J | | |
| 1522 | " | " | Scapolite and Phlogopite | 1 | Franklin, N. J | | |
| 1523 | " | " | Barite | 1 | England | | |
| 1524 | " | " | Schorlomite and Garnet | 1 | Magnet Cove, Ark | | |
| 1525 | " | " | Halloysite (Indianaite) | 1 | Indiana | | |
| 1526 | " | " | Unknown | 1 | Bergen Hill, N. J | | |
| 1527 | " | " | Pyrite | 1 | Roxbury, Ct | | |
| 1528 | " | " | Bornite and Chalcopyrite | 1 | Bristol, Ct | | |
| 1529 | " | " | Gold Quartz | 1 | Victoria, Australia | | |
| 1530 | " | " | Hematite (Specular Iron.) | 1 | Germany | | |
| 1531 | " | " | "Sussexite," (Rare) | 23 | Franklin, N. J | | |
| 1532 | " | " | Lepidolite | 1 | Hebron, Maine | | |
| 1533 | " | " | Phillipsite in Trachyte | 1 | Italy | | |
| 1534 | " | " | Chalcostibite (Antimonial Copper) | 1 | Chili | | |
| 1535 | " | " | Garnet (Colophonite) | 1 | Franklin, N. J. | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formotion | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1536 | Nov. 1876 | Geo. F. Kunz | Willemite (Troostite) and Calcite (Spartaite) | 1 | Franklin, N. J | | |
| 1537 | " | " | Willemite and Calcite (Spartaite) | 2 | " | | |
| 1538 | " | " | Franklinite and Calcite (Spartaite) | 8 | " | | |
| 1539 | " | " | Franklinite and Rhodochrosite [Dialogite] | 1 | " | | |
| 1540 | " | " | Soda Nitre [Nitratine] | 3 | Plainsof TerrapaccaS.A | | |
| 1541 | " | " | Datolite [Massive] | 1 | Bergen Hill, N. J | | |
| 1542 | " | " | Galenite | 1 | Spain | | |
| 1543 | " | " | Galenite | 2 | Illinois | | |
| 1544 | " | " | Tourmaline | 2 | Franklin, N. J | | |
| 1545 | " | " | Prehnite and Copper | 1 | Lake Superior | | |
| 1546 | " | " | "Tvigtite" | 1 | Tvigtut, Greenland | | |
| 1547 | " | " | Quartz [Amethyst] | 3 | Lancaster Co., Pa | | |
| 1548 | " | " | Apophyllite and Pectolite [primitive] | 1 | Bergen Hill, N. J | | |
| 1549 | " | " | Vanadinite [Crystallized] | 1 | Corinthia, Europe | | |
| 1550 | " | " | Datolite and Yellow Stilbite | 1 | Bergen Hill, N. J | | |
| 1551 | " | " | Pyrite | 1 | | | |
| 1552 | " | " | Orthoclase | 12 | Colorado | | |
| 1553 | " | " | Garnet | 5 | New Town Ct | | |
| 1554 | " | " | Brookite | 12 | Magnet Cove, Ark | | |
| 1555 | " | " | Staurolite | 3 | New Hampshire | | |
| 1556 | " | " | Aluminite [Hallite] | 4 | Notingham, Pa | | |
| 1557 | " | " | Chlorastrolite | 40 | Isle Royale, L. Superior | | Rare in Rock |
| 1558 | " | " | Azurite | 1 | Chessy, France | | |
| 1559 | " | " | Stibiconite [Partzite and Stetefeldtite] | 1 | Belmont, Nevada | | |
| 1560 | " | " | Algodonite | 1 | Chili | | |
| 1561 | " | " | Cassiterite [Stream Tin] | 20 | Durango, Mexico | | |
| 1562 | " | " | Brookite [Arkansite] and Rutile ? [Nigrine] | Indf | Magnet Cove, Ark | | Small and numerous |

## *Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial No. | Obtained. | | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1563 | Nov. 1876 | Geo. F. Kunz | Brookite [Arkansite] | 14 | Magnet Cove, Ark | | Small and numerous |
| 1564 | " | " | Topaz [rite. | 10 | Durango, Mexico | | |
| 1565 | " | " | Titanite [Green Sphene] with Ripidolite [Chlo- | 2 | Tyrol | | |
| 1566 | " | " | Rutile | 9 | Lynchburg, Va | | |
| 1567 | " | " | Native Lead | 1 | Granada, Spain | | |
| 1568 | " | " | Vivianite | 5 | Mullica Hill, N. J | | |
| 1569 | " | " | Cassiterite [Stream Tin] | 14 | Durango, Mexico | | |
| 1570 | " | " | Microlite | 2 | Chesterfield, Mass | | |
| 1571 | " | " | Atacamite | 1 | Chili | | |
| 1572 | " | " | Spinel [Ruby] | 20 | Franklin, N. J | | |
| 1573 | " | " | "Stevensite" | 5 | Bergen Hill, N. J | | |
| 1574 | " | " | Fibrous Malachite | 1 | Germany | | |
| 1575 | " | " | Quartz | 1 | | | |
| 1576 | " | " | Mica and Spinel [Ruby] | 1 | Franklin, N. J | | |
| 1577 | " | " | Amphibole [Hornblende] | 1 | Spain | | |
| 1578 | " | " | Gismondite and Analcite | 1 | Cyclopean Islands | | |
| 1579 | " | " | Laumontite and Datolite | 2 | Bergen Hill, N. J | | |
| 1580 | " | " | Quartz [Carnelian] | 1 | Germany | | |
| 1581 | " | " | Chrysocolla | 6 | Chili, S. A | | |
| 1582 | " | " | Smoky Quartz | 1 | St. Gothard, Switzerl'nd | | |
| 1583 | " | " | Chrysolite [Olivine] | 3 | Arizona | | |
| 1584 | " | " | Quartz [Amethyst] | 3 | Brazil | | |
| 1585 | " | " | Lapis-Lazuli | 1 | Siberia | | |
| 1586 | " | " | "Black Mica" | 2 | New York City | | |
| 1587 | " | " | Iridescent Franklinite and Willemite | 1 | Franklin, N. J | | |
| 1588 | " | " | Opal | 1 | North Carolina | | |
| 1589 | " | " | Ruby, Sapphire, &c | 75 | Franklin, N. J | | Indefinite |

## *Catalogue of Specimens Rigistered in the General Museum in 1877*—Continued.

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|---|---|---|---|---|---|---|---|
| 1590 | Nov. 1876 | Geo. F. Kuntz | Epidote | 1 | Tyrol, Europe | | |
| 1591 | " | " | Quartz crystal penetrated by another crystal | 1 | Herkimer Co., N. Y. | | |
| 1592 | " | " | Talc [Steatite, Pseudo-after Staurolite] | 1 | Germany | | |
| 1593 | " | " | Stromeyerite | 1 | Arizona | | |
| 1594 | " | " | Quartz [Black Jasper] | 1 | Europe | | |
| 1595 | " | " | Quartz [Sard or Carnelian] | 1 | Europe | | |
| 1596 | " | " | Native silver | 1 | Mexico | | |
| 1597 | " | " | Natrolite | 1 | Vesuvius, Italy | | |
| 1598 | " | " | Green quartz containing ripidolite [Chlorite] | 1 | Olisville, N. Y. | | |
| 1599 | " | " | Calcite | 1 | Lake Superior | | |
| 1600 | " | " | Quartz containing Psilomelane | 1 | Hot Springs, Ark. | | |
| 1601 | " | " | Opal | 10 | Hungary | | |
| 1602 | " | " | Amphibole [Asbestus] | 1 | North Carolina... [Ark. | | |
| 1603 | " | " | "Quartz Cappings." | 3 | 40 m. from Hot Springs, | | |
| 1604 | " | " | Columbite | 10 | Haddam, Ct. | | |
| 1605 | " | " | Quartz | 28 | Herkimer, Co., N. Y. | | |
| 1606 | " | " | Kalinite [Native Alum] | 1 | Mt. Morris, N. Y. city | | |
| 1607 | " | " | Diamond | 1 | South Africa | | |
| 1608 | " | " | Topaz [Colored] | Indf | Durango, Mexico | | |
| 1609 | " | " | Topaz [doubly terminated] | 1 | " " | | |
| 1610 | " | " | "Durangite." | Indf | " " | | From stream—tin. |
| 1611 | " | " | Zircon | 3 | Franklin, N. J. | | |
| 1612 | " | " | "Syngenite" | 1 | Poland, Galacia | | Very rare. |
| 1613 | " | " | Iridosmine | .... | Oregon | | |
| 1614 | " | " | Menaccanite [Titanic iron sand containing gold garnet and zircon | Indf | " | | |
| 1615 | " | " | Menaccanite [Iserina] | Indf | Switzerland | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

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|---|---|---|---|---|---|---|---|
| 1616 | Nov. 1876 | Geo. F. Kuntz | Dioptase | 1 | Ghergles Steppes, Siberia | | |
| 1617 | " | " | Quartz [Agate and Chlorastrolite] | Indf | Isle Royal, L. S. | | |
| 1618 | " | " | Mellite [Honey Stone] | 2 | Thuringia | | |
| 1619 | " | " | Silver [wire] | | Mexico | | |
| 1620 | " | " | Beryl | 1 | Siberia | | |
| 1621 | " | " | Apatite | 1 | Rosse, N. Y. | | |
| 1622 | " | " | Nytive Tellurium | 1 | Transylvania | | |
| 1623 | " | " | Apatite | 2 | | | |
| 1624 | " | " | Topaz | 7 | Brazil | | |
| 1625 | " | " | Andalusite [Chiastolite] | 1 | Massachusetts | | |
| 1626 | " | " | Cassitere [stream tin] with topazes and "Durangite." | Indf | Durango, Mexico | | |
| 1627 | " | " | Amphibole [Amianthus] | | North Carolina | | |
| 1628 | " | " | Native copper | 1 | Lake Superior | | From a fissure |
| 1629 | " | " | Geode | 1 | Iowa | | |
| 1630 | " | " | Quartz [Chalcedony after wood] | 1 | California | | |
| 1631 | " | " | Quartz [Silicified wood] | 1 | Nevada Co. Nev. | | |
| 1632 | " | " | Asphaltum [Albertite] | 3 | Nova Scotia | | |
| 1633 | " | " | Kieserite | | Stassfurt, Germany | | |
| 1634 | " | " | Glauberite | | Laramie Plaines, U. S. | | |
| 1635 | " | " | Picromerite ]Kainite] | | Stassfurt, Germany | | |
| 1636 | " | " | Sylvite | | " " | | |
| 1637 | " | " | Tachhydrite | | " " | | |
| 1638 | " | " | Polyhalite | | " " | | |
| 1639 | " | " | Carnallite | | " " | | [of University of Va. |
| 1640 | " | " | Meteoric iron | | Virginia | | Fall of 1868 from Prof. Mallet, |
| 1641 | " | " | Gold | 1 | Nova Scotia | | |
| 1642 | " | " | Orthaclase [Amazon Stone] | 1 | Pike's Peak, Col | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

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|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1643 | Nov. 1876 | Geo. F. Kunz | Graphite | 5 | Ceylon | | |
| 1644 | " | " | Kaolinite | 5 | England | | |
| 1645 | " | " | Kaolinite | 3 | Delaware | | |
| 1646 | " | " | Chrysoberyl | 1 | Greenfield, N. Y. | | |
| 1647 | " | " | Chalcopyrite and Seybertite (Clintonite) | 1 | Franklin, N. J. | | |
| 1648 | " | " | Gold | 1 | Australia | | |
| 1649 | " | " | "Silver ore" | 1 | White Pne, Col. | | |
| 1650 | " | " | Gypsum (Selenite) | 1 | Zanesville, Ohio | | |
| 1651 | " | " | Scolecite | 1 | Poonah, India | | |
| 1652 | " | " | Lava, with coin put in while hot | 1 | Vesuvius, Italy | | |
| 1653 | " | " | Lazulite | 6 | Lincoln Co., Georgia | | |
| 1654 | " | " | Limonite | 2 | Near Franklin, N. J. | | |
| 1655 | " | " | Quartz (Amethyst) | 2 | England | | |
| 1656 | " | " | Amphibole [Asbestus] | 5 | Staten Island, N. Y. | | |
| 1657 | " | " | Mineral coal [Peacock coal] | 4 | Wilkesbarre, Pa. | | |
| 1658 | " | " | White Staurolite | | Hanover, N. H. | | |
| 1659 | " | " | Native Silver | | Chili, S. A. | | |
| 1660 | " | " | Gold and Silver | | Gould & Curry mine, Cal | | |
| 1661 | " | " | Serpentine [Antigorite] | | Antigoras, Piedmont | | |
| 1662 | " | " | Quartz [Amethyst] | | Hugnary | | |
| 1663 | " | " | Molybdite | | Strahope, N. J. | | |
| 1664 | " | " | Biotite | | New York State | | |
| 1665 | " | " | Calcite | | Rossie, N. Y. | | |
| 1666 | " | " | Amphibole [Radiated Tremolite] | | Barrington, Mass. | | |
| 1667 | " | " | Octahedrite [Anatase] and Quartz | | St. Gothard, Switz. | | |
| 1668 | " | " | Lava | 2 | Vesuvius, Italy | | |
| 1669 | " | " | Lava | | Sandwich Islands | | |

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|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1670 | Nov. 1876 | Geo. F. Kunz | Pyrite | 1 | Jeddo Coal Mines, Pa. | | |
| 1671 | " | " | Pyrite | 1 | Rossie, N. Y. | | |
| 1672 | " | " | Rutile | 2 | Lincoln Co., Georgia | | |
| 1673 | | | Rutile | 1 | Lancaster Co., Pa. | | |
| 1674 | " | " | Black Tourmaline | 1 | Rossie, N. Y. | | |
| 1675 | | | Tourmaline | 1 | Haddam, Ct. | | |
| 1676 | " | " | "Black Mica" | 1 | Franklin, N. J. | | |
| 1677 | " | " | "Mica, magnetited" | 3 | New York City | | |
| 1678 | " | " | Quartz | 1 | Dubuque, Iowa | | |
| 1679 | " | " | Pyrite Sphaerite (dodecahedral Blende) | 1 | Pike's Peak, Col. | | |
| 1680 | " | " | Magnetite (native Magnet) | 4 | Magnet Cove, Ark. | | |
| 1681 | " | " | Chalcanthite (native Sulphate of Copper) | | Cornwall, England | | |
| 1682 | " | " | Gypsum | 3 | Mammoth Cave, Ky. | | |
| 1683 | " | " | Kaolinite (Argilliform) | 2 | Woodbridge, N. J. | | |
| 1684 | " | " | Odd Quartz | 1 | Magnet Cove, Ark. | | |
| 1685 | " | " | Doubly Terminated Milky Quartz | 1 | Magnet Cove, Ark. | | |
| 1686 | " | " | Quartz | 1 | Phœnixville, Pa. | | |
| 1687 | " | " | Calcite | 1 | Lake Superior | | Rock on which Duluth is built. |
| 1688 | " | " | "Satin Spar" | 4 | Nova Scotia | | |
| 1689 | " | " | Quartz in Calc. Sand Rock | 7 | Herkimer Co., N. Y. | | |
| 1690 | " | " | Asphaltum (Bitumen, on Quartz calc. Sand R'k | 1 | Herkimer Co., N. Y. | | |
| 1691 | " | " | "Mica, magnetited" | 1 | New Hampshire | | |
| 1692 | " | " | Galenite | 1 | Colorado | | |
| 1693 | " | " | Sphalerite (Blende) | 2 | Phœnixville, Pa. | | |
| 1694 | " | " | Tourmaline | 6 | Chester, Mass. | | |
| 1695 | " | " | Celestite | 1 | Mt. Gergenti, Sicily | | |
| 1696 | " | " | Quartz (Amethyst) and Fluorite | 1 | England | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. | | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1697 | Nov. 1876 | Geo. F. Kunz | Halite | 4 | St. Martinsville, La. | | |
| 1698 | " | " | Halite | 1 | Utah Territory | | |
| 1699 | " | " | Limonite after Pyrite | 1 | Pennsylvania | | |
| 1700 | " | " | Sphalerite [Blende] and Galenite on Quartz | 1 | | | |
| 1701 | " | " | Gypsum [Selenite] | 1 | Cayuga Lake, N. Y. | | |
| 1702 | " | " | Barite | 1 | Gibralter | | |
| 1703 | " | " | Calc:te ]Calc Tufa] | 1 | Litchfield, N. Y. | | |
| 1704 | " | " | Allanite | 5 | Franklin, N. J. | | |
| 1705 | " | " | Jefferisite | 4 | Westchester,Ch'r Co.Pa | | |
| 1706 | " | " | Muscovite | 2 | Jefferson Co. N. Y. | | |
| 1707 | " | " | Jeffersite | 2 | Connecticut | | |
| 1708 | " | " | Serpentine | 1 | Pennsylvania | | |
| 1709 | " | " | Chalcocite [Sulphide of Copper] after Wood | 1 | New Mexico | | |
| 1710 | " | " | Azurite and Malachite | 1 | " | | |
| 1711 | " | " | Gypsum | 1 | Dubuque, Iowa | | |
| 1712 | " | " | Amphibole [Tremolite] in Dolomite | 2 | Lee, Mass. | | |
| 1713 | " | " | Garnet | 1 | Hanover, N. H. | | 1 |
| 1714 | " | " | Strontianite | 1 | England | | |
| 1715 | " | " | Magnesite [White, Compact] | 1 | Hoboken, N. J. | | |
| 1716 | " | " | Malachite | 3 | Chili, S. A. | | |
| 1717 | " | " | Gypsum [Alabaster] | 1 | Cape Breton, N. S. | | |
| 1718 | " | " | Green Tourmaline | 1 | Paris, Maine | | |
| 1719 | " | " | Limonite | 1 | Chestnut Hill,LanCo Pa | | |
| 1720 | " | " | Calcite [" Rock Milk "] | 1 | Watertown, N. Y. | | |
| 1721 | " | " | Gothite [Lepidocrocite] | 1 | Chestnut Hill, Pa. | | |
| 1722 | " | " | Aragonite, " Mexican Onyx " | 1 | Mexico | | |
| 1723 | " | " | Stilpnomelane [Chalcodite] | 1 | Sterling MineAnw'pNY | | |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1724 | Nov. 1876 | Geo. F. Kunz | Ægirite (Black) | 1 | 40 mile w Mag. Cove, Ark | | |
| 1725 | " | " | Euxenite | 1 | Norway | | |
| 1726 | " | " | Embolite | 1 | Silver City, Colorado | | The "Bogus Silver Ore" from Western Boulevard and 105 st. N. Y. City caused great excite ment |
| 1727 | " | " | Pyrite in Gneiss | 1 | New York City | | |
| 1728 | " | " | Rhodonite (Fowlerite) | 1 | Franklin, N. J. | | |
| 1729 | " | " | Chabazite (White) | 1 | Ausig, Bohemia | | |
| 1730 | " | " | Anorthite (Indianite) | 2 | Chester, Mass. | | |
| 1731 | " | " | Limonite (Bog Iron Ore, after Wood) | 1 | New York State | | |
| 1732 | " | " | Calcite (Fibrous Carb. of Lime) | 2 | Chicopee, Mass | | |
| 1733 | " | " | Fluorite | 1 | Derbyshire England | | |
| 1734 | " | " | Porphyry [dite | 1 | Spain | | |
| 1735 | " | " | Cassiterite Fluorite and Lepidolite (Zinnwal- | 1 | Paris, Maine | | |
| 1736 | " | " | Fetid Limestone | 1 | Massachusetts | | |
| 1737 | " | " | Albite | 2 | New York City | | |
| 1738 | " | " | Berthierite | 1 | Hayunge, Depar't of the Mosselle, France | | |
| 1739 | " | " | Malachite | 1 | New Mexico | | |
| 1740 | " | " | Prehnite | 1 | Tyrol | | |
| 1741 | " | " | Serpentine (Williamsite) | 1 | Pennsylvania | | |
| 1742 | " | " | Calcite (Dog-Tooth Spar) [domelane | 1 | Bergen Hill, N. J. | | |
| 1743 | " | " | Cancrinite with Torbernite (Chalcolite) Lepi- | 3 | Litchfield, Me. | | |
| 1744 | " | " | Triphylite | 1 | Grafton, Vr. | | |
| 1745 | " | " | Titanite (Sphene, Lederite) | 1 | New York | | |
| 1746 | " | " | Titanite (Lederite) | 2 | Franklin, N. J. | | |
| 1747 | " | " | Limonite coating Pyrite | 1 | Pennsylvania | | |
| 1748 | " | " | Phlogopite | 1 | Canada | | |
| 1749 | " | " | Samarskite | 1 | North Carolina | | |
| 1750 | " | " | "Zonochlorite" | 1 | Hudson Bay Territory | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. | | Name. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1751 | Nov. 1876 | Geo. F. Kunz | Celestite on Sulphur | 3 | Mt. Girgenti, Sicily | | |
| 1752 | " | " | Cryolite, Sphalerite and Pyrite | 1 | Ivigtut, Greenland | | |
| 1753 | " | " | Garnet | 1 | New York City | | |
| 1754 | " | " | Covellite | 1 | Chili | | |
| 1855 | " | " | Asphaltum | 1 | Egypt | | |
| 1756 | " | " | Fluorite [Fluate of lime] | 2 | Columbia, Pa. | | In Furnace Slag, St. Charles [furnace. |
| 1757 | " | " | Amphibole [Tremolite] | 1 | Hartz, Germany | | |
| 1758 | " | " | Brucite | 2 | Hoboken, N. J. | | Of rare occurrence at Hoboken |
| 1759 | " | " | Vanadinite | 1 | Lead Hills, Scotland | | |
| 1760 | " | " | Pyrite | 2 | England | | |
| 1761 | " | " | Gypsum, [Selenite, single crystal.] | 1 | Paris, France | | |
| 1762 | " | " | Gypsum, [Selenite, twin crystals] | 1 | " | | |
| 1763 | " | " | Vesicular lava with chrysolite | 1 | Sandwich Islands | | |
| 1764 | " | " | "Carbonite." | 1 | Near Richmond, Va. | | |
| 1765 | " | " | Peganite | 2 | Near Hot Springs, Ark. | | |
| 1766 | " | " | Genthite on Chromite | 1 | Wood's mine Lanc'r Co. [Pa. | | |
| 1767 | " | " | Blue Calcite | 1 | Lake Champlain | | |
| 1768 | " | " | Cancrinite with Nephelite [Elæolite] Lepidom- [elane. | 1 | Litchfield, Me | | |
| 1769 | " | " | Prehnite | 1 | Simsbuby, Conn. | | |
| 1770 | " | " | Opal [Hyalite] | 1 | England | | |
| 1771 | " | " | Calcite [Satin Spar] | 1 | Chicopee, Mass. | | |
| 1772 | " | " | Limonite ["Pipe Ore."] | 2 | Near Easton, Pa. | | |
| 1773 | " | " | Hollowed Analcite | 1 | Bergen Hill, N. J. | | |
| 1774 | " | " | Schistose Hematite | 1 | Bachman Val. Carrol Co. [Md. | | |
| 1775 | " | " | Pyroxene [Augite] in Lava | 1 | Vesuvius, Italy | | |
| 1776 | " | " | Margarodite | 1 | Chester, Mass. | | |
| 1777 | " | " | "From a zinc furnace" | 1 | Virginia | | Forty per cent. zinc |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1778 | Nov. 1876 | Geo. F. Knnz | Melaconite (Tenorite) | 1 | Chili | | |
| 1779 | " | " | Siderite (Sphero siderite) | 1 | New York City | | |
| 1780 | " | " | Samarskite | 1 | North Carolina | | Crystal |
| 1781 | " | " | Mimetite (Campylite) | 1 | Dry gill, England | | |
| 1782 | " | " | Hubnerite | 1 | California | | |
| 1783 | " | " | Celestite | 1 | Magnet Cove, Ark | | |
| 1784 | " | " | Tourmaline and oligoclase | 2 | Green Island, Lake Erie | | |
| 1785 | " | " | Dolomite (Pearl spar) with Fluorite | 1 | New York City | | |
| 1786 | " | " | Grey Tephroite, Franklinite and zincite | 1 | Lockport, N. Y | | |
| 1787 | " | " | Quartz (Chalcedony) | 1 | Franklin, N. J | | |
| 1788 | " | " | "Jade" | 1 | Italy | | |
| 1789 | " | " | Pyromorphite on quartz | 1 | Easton, Pa | | |
| 1790 | " | " | Elaterite (Elastic Bitumen) | 3 | Phœnixville, Pa | | |
| 1791 | " | " | Black Garnet containing schorlomite | 1 | Derbyshire, Eng | | |
| 1792 | " | " | Radiated gypsum | 1 | Marseilles, France | | |
| 1793 | " | " | Menaccanite in talc | 1 | Harford Co. Md | | |
| 1794 | " | " | Quartz (Jasper) | 1 | Massachusetts | | |
| 1795 | " | " | Talc | 1 | St. Lawrence Co., N. Y. | | |
| 1796 | " | " | Serpentine and Calcite (Argentine) | 1 | Montville, N. J. | | |
| 1797 | " | " | Enargite | 1 | Alpine Co., Cal | | [Plaster of Paris came. |
| 1798 | " | " | Gypsum | 1 | Paris, France | | Quarry from which the name |
| 1799 | " | " | Hydrodolomite | 1 | Westchester Co., N. Y. | | |
| 1800 | " | " | Phenite | 1 | Lake Superior | | |
| 1801 | " | " | Arsenic (native) | 1 | Germany | | |
| 1802 | " | " | Vivianite | 1 | Monmouth Co., N. J | | |
| 1803 | " | " | Wolframite (pseudo after Scheelite) | 1 | Connecticut | | |
| 1804 | " | " | Calcite (Stalactite) | 1 | Dubuque, Iowa | | |

## Catalogue of Specimens Registered in the General Museum in 1877—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1805 | Nov. 1876 | Geo. F. Kunz | Quartz | 2 | Magnet Cove, Ark | | |
| 1806 | " | " | Amphibole (Actinolite) | 1 | Holliston, Mass | | |
| 1807 | " | " | Fluorite | 1 | Hardin Co., Ill | | |
| 1808 | " | " | Sphalerite [Blende, showing cleavage] | 1 | Granby, Mo | | |
| 1809 | " | " | Mineral Coal [Lignite Coal | 1 | Isthmus of Panama | | |
| 1810 | " | " | Tourmaline [Indicolite] and Beryl [Goshenite] | 1 | Goshen, Mass | | |
| 1811 | " | " | Witherite [radiated] | 1 | Newcastle, Eng | | |
| 1812 | " | " | Chalcocite | 1 | Liberty Mine, Md | | |
| 1813 | " | " | Dolomite [Pearl Spar] | 1 | Lancaster Co., Pa | | |
| 1814 | " | " | Lesleyite | 1 | Newlin, Chester Co., Pa | | |
| 1815 | " | " | Amphibole [Amianthus] | 1 | Harford Co., Md | | |
| 1816 | " | " | Zircon | 7 | Buncome Co., N. C | | |
| 1817 | " | " | Pinite [Gieseckite] | 1 | Nat.Br'dg,Lewis Co.N.Y | | |
| 1818 | " | " | "Porcelain Jasper" | 1 | Germany | | |
| 1819 | " | " | Brookite [Arkansite, in quartz] | 1 | Magnet Cove, Ark | | |
| 1820 | " | " | Zincite [Oxide of Zinc] | 2 | Franklin, N. J | | From fused ore heap |
| 1821 | " | " | Green Wavellite | 2 | Hot Springs, Ark | | |
| 1822 | " | " | Pink Spinel in Pyroxene [Sahlite] | 1 | Vernon, N. J | | |
| 1823 | " | " | Adamite | 1 | Toulon, France | | |
| 1824 | " | " | Pyroxene | 1 | Northern, N. Y | | |
| 1825 | " | " | Radiated Ripidolite | 2 | New York City | | |
| 1826 | " | " | Aragonite | | Mt. Girgenti, Sicily | | |
| 1827 | " | " | Brucite | | Wood'sMine.Lan co.Pa. | | |
| 1828 | " | " | Azurite and Malachite | 3 | Franklin, N. J | | |
| 1829 | " | " | Pyromorphite | 3 | Phœnixville, Pa | | |
| 1830 | " | " | Magnetite (magnetic iron sand) | | Long Island Beach | | |
| 1831 | " | " | Magnetite | 5 | Near Stockholm, N. J | | Ogden mine |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Seiral Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1832 | Nov. 1876 | Geo. F. Kunz | Magnetite | 3 | Near Bloomington, N. J | | |
| 1833 | " | " | Magnetite | 3 | Roseville, N. Y | | |
| 1834 | " | " | Magnetite | 1 | Byram, N. J | | |
| 1835 | " | " | Magnetite | 1 | New Jersey | | |
| 1836 | " | " | Magnetite | 2 | Woodsport, N. J | | |
| 1837 | " | " | Magnetite | 12 | Franklin, N. J | | |
| 1838 | " | " | Stibnite | 3 | Hungary | | |
| 1839 | " | " | Petrified wood | 1 | Middle Park, Col | | |
| 1840 | " | " | Petrified wood | 1 | Colorado | | |
| 1841 | " | " | Petrified wood | 1 | Colorado | | |
| 1842 | " | " | Siderite (Carbonate of Iron) | 1 | New York City | | |
| 1843 | " | " | Asphaltum | 1 | Bex, Switzerland | | |
| 1844 | " | " | Mineral Coal (Lignite) with Pyrite | 1 | Ohio | | |
| 1845 | " | " | Result of decomposition of Pyrite | 1 | Bergen Hill, N. J | | |
| 1846 | " | " | Tourmaline (bent crystals) | 1 | Cecil Co., Md | | |
| 1847 | " | " | Chromite | 1 | Wood's mine, Lan. co. Pa | | |
| 1848 | " | " | Cryolite with Siderite | 1 | Arksut Bay, Greenland | | |
| 1849 | " | " | Cyanite | 2 | Newton, Conn | | |
| 1850 | " | " | Limonite | 10 | Hamburg, N. J | | |
| 1851 | " | " | Pyrite | 1 | Bergen Hill, N. J | | |
| 1852 | " | " | Galenite | 1 | Phœnixville, Pa | | |
| 1853 | " | " | Magnetite | 1 | Dickinson Mine, N. J | | |
| 1854 | " | " | Anthophyllite | 1 | Smithfield, R. I | | |
| 1855 | " | " | Allanite (Orthite, crystals) | 2 | New York City | | |
| 1856 | " | " | Ripidolite (Chlorite) | 1 | Franklin, N. J | | |
| 1857 | " | " | Amphibole (Byssolite) and Ægirite | 1 | Hot Springs, Ark | | |
| 1858 | " | " | Gothite (Feathery Lepidocrocite) | 2 | Chestnut Hill, Pa | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

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|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1859 | Nov. 1876 | Geo. F. Kunz | Serpentine | 1 | Franklin, N. J | | |
| 1860 | " | " | Stilbite resembing Wavellite | 1 | Philadelphia, Pa | | |
| 1861 | " | " | Aragonite (ite) Crystals | 1 | Franklin, N. J | | |
| 1862 | " | " | Garnet (Colophonite) and Rhodonite (Fowler- | 1 | " | | |
| 1863 | " | " | Brown Hematite | 2 | Friedensville, Pa | | |
| 1864 | " | " | Calamine | 1 | " | | |
| 1865 | " | " | Epidote on Orthoclase | 1 | New York City | | |
| 1866 | " | " | "Scapolite" | 1 | Lewis Co. N. J | | |
| 1867 | " | " | Brookite | 2 | Arkansas | | |
| 1868 | " | " | Native Copper | 1 | Marqueette Co. Mich | | |
| 1869 | " | " | Calamine | 1 | Bethlehem, Pa | | |
| 1870 | " | " | Magnesite (Brennerite) | 1 | Massachusetts | | |
| 1871 | " | " | Limonite and Smithsonite | 1 | Franklin, N. J | | |
| 1872 | " | " | Niccoliferous Pyrrhotite | 1 | Lancaster Co. Pa | | |
| 1873 | " | " | Calcite (Argentine) and Serpentine | 1 | Montville, N. J | | |
| 1874 | " | " | Enstatite (Bronzite) | 1 | Texas, Lancaster Co. Pa | | |
| 1875 | " | " | Ægirite | 1 | Hot Springs, Ark | | |
| 1876 | " | " | Hydromagnesite | 3 | Lancaster Co., Pa | | |
| 1877 | " | " | Jadeite | 2 | Easton, Pa | | |
| 1878 | " | " | Domeykite | 1 | Chili, S. A | | |
| 1879 | " | " | Copper in calcite | 1 | Lake Superior | | |
| 1880 | " | " | Hydrodolomite (Pennite) | 1 | Lancaster Co. Pa | | |
| 1881 | " | " | Ripidolite (Clinochlore) | 1 | Franklin, N. J | | |
| 1882 | " | " | Witherite on Water Lime | 7 | Rondout, N. Y | | Only American locality |
| 1883 | " | " | Barite, Malachite and Quartz | 1 | Cheshire, Ct | | |
| 1884 | " | " | Manganite | 1 | Nova Scotia | | |
| 1885 | " | " | Malachite in Ochre | 1 | Maryland | | |

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|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1886 | Nov. 1876 | Geo. F. Kunz | Flesh-colored Quartz Rock | 1 | Burlington, Vt. | | |
| 1887 | " | " | Pele's Hair | Indf | Sandwich Islands | | |
| 1888 | " | " | "Mica" | 3 | Franklin, N. J. | | |
| 1889 | " | " | Datolite (Oil green variety) | 1 | Bergen Hill, N. J. | | |
| 1890 | " | " | Prehnite with vein of "Stevensite" | 1 | " | | |
| 1891 | " | " | Gœthite (Lepidocrocite) | 1 | Chestnut Hill, Pa. | | |
| 1892 | " | " | Tourmaline | 1 | Chester, Mass. | | |
| 1893 | " | " | Red Hematite | 1 | Franklin, N. J. | | |
| 1894 | " | " | Graphite | 35 | New Jersey | | |
| 1895 | " | " | Arsenopyrite (Mispickel) | 1 | Roxbury, Ct. | | |
| 1896 | " | " | Dendrite | 1 | Franklin, N. J. | | |
| 1897 | " | " | Feldspar on Trap | 1 | Bergen Hill, N. J. | | |
| 1898 | " | " | Gold in Quartz | 1 | California | | |
| 1899 | " | " | Seybertite (Clintonite) and Chalcopyrite | 1 | Franklin, N. J. | | |
| 1900 | " | " | Epidote, Orthoclase and Copper | 1 | Lake Superior | | |
| 1901 | " | " | Siderite | 1 | England | | |
| 1902 | " | " | Fluorite | 1 | Mine Hill, Franklin, N.J. | | |
| 1903 | " | " | Penninite | 1 | Lows Mine, Tex. Lan.Co [Pa | | Lows Mine |
| 1904 | " | " | Green Quartz | 1 | Staten Island N.J. | | |
| 1905 | " | " | Zircon on Feldspar | 1 | Diana N. J. | | |
| 1906 | " | " | Magnesite | 1 | Hoboken N. J. | | |
| 1907 | " | " | Sodalite | 1 | Salem, Mass. | | |
| 1908 | " | " | Willemite | 1 | Passaic Mine, Franklin, [N. J. | | |
| 1909 | " | " | Orthoclase and Epidote | 1 | New York City | | |
| 1910 | " | " | "Mica" | 1 | Chesterfield, Mass. | | |
| 1911 | " | " | Aragonite | 2 | Franklin, N. J. | | |
| 1912 | " | " | Turgite (Hydrohematite) | 2 | Chestnut Hill, Pa. | | |

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|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 1913 | Nov. 1876 | Geo. F. Kunz | Pectolite and Datolite | 1 | Bergen Hill, N. J | | |
| 1914 | " | " | Goethite (Lepidocrocite) | 1 | Chestnut Hill, Pa | | |
| 1915 | " | " | Magnetite (Native magnet) | 1 | Union Town, N. J | | |
| 1916 | " | " | Ruby zinc, Dialogite and "Sussexite" | 1 | Franklin, N. J | | |
| 1917 | " | " | Brookite (Arkansite) | 1 | Magnet Cove, Ark | | |
| 1918 | " | " | Apophyllite and Stilbite | 1 | Bergen Hill, N. J | | |
| 1919 | " | " | Apophyllite and Datolite | 2 | " " | | |
| 1920 | " | " | Apophyllite (modified) | 1 | " " | | |
| 1921 | " | " | Laumontite | 2 | " " | | |
| 1922 | " | " | Titanite (Sphene) | 1 | Amity, N. Y | | |
| 1923 | " | " | Tourmaline | 1 | | | |
| 1924 | " | " | Fossiliferous Hematite | 1 | Oneida, N. Y | | |
| 1925 | " | " | Analcite, Apophyllite and Natrolite | 1 | Bergen Hill, N. J | | |
| 1926 | " | " | Rhodonite | 2 | Cummington, Mass | | |
| 1927 | " | " | Muscovite | 2 | New Hampshire | | |
| 1928 | " | " | Rhodonite (Cummingtonite) | 1 | Cummington, Mass | | |
| 1929 | " | " | Chrysocolla and green quartz | 1 | Chili, S. A | | |
| 1930 | " | " | Melanterite (native copperas) | 1 | Staten Island, N. Y | | From Iron mine |
| 1931 | " | " | Copper on quartz | 1 | Lake Superior, Mich | | Central mine |
| 1932 | " | " | Garnet (Colophonite) | 1 | Franklin, N. J | | |
| 1933 | " | " | Quartz (Silicified wood) | 1 | Southern Georgia | | |
| 1934 | " | " | Wenerite (Lilac Scapolite) | 1 | Bolton, Mass | | |
| 1935 | " | " | Garnet [stone. | 1 | New Jersey | | Not found in any other locality and not described in the books. Very handsome when polished across the cut of the concretions. |
| 1936 | " | " | Calcite (concretionary marble) on fetid lime- | 1 | Holyoke, Mass | | |
| 1937 | " | " | "Montebrasite." | 1 | Montebras, Creiese Fr. | | |
| 1938 | " | " | Gold and Silver ore [spar.) | 1 | East Creek, N. J | | Belden's Mine. |
| 1939 | " | " | Calcite (dog-tooth spar) and Dolomite (Pearl | 1 | Lockport N. Y | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

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|---|---|---|---|---|---|---|---|
| 1940 | Nov. 1876 | Geo. F. Kunz | Datolite (in small crystals) | 1 | Bergen Hill, N. J | | |
| 1941 | " | " | Lepidolite | 1 | Alterberg, Saxony | | |
| 1942 | " | " | Calcite | 1 | Warwick, N. Y | | |
| 1943 | " | " | Slag from Furnace | 1 | Patterson, N. J | | |
| 1944 | " | " | Calcite | 1 | Bellville, N. J | | From old copper mine. |
| 1945 | " | " | Iridescent Pyrite | 1 | Scales Mound, Galena Ill | | |
| 1946 | " | " | Amphibole (actinolite) | 1 | Black Horse, Del | | |
| 1947 | " | " | Amphibole (actinolite) | 2 | 63rd St. New York City | | |
| 1948 | " | " | Orthoclase (Amazon stone) | 1 | Mineral Hill, Pa | | |
| 1949 | " | " | Calcite, Pyrite and Specular iron | 1 | Antwerp, N. Y | | |
| 1950 | " | " | Amygdaloid containing zeolites | 1 | Poonah. Hindostan | | |
| 1951 | " | " | Gangue rock of Cassiterite (Tinstone) | 1 | Durango, Mexico | | |
| 1952 | " | " | Opal | 1 | Rocky Mountains | | |
| 1953 | " | " | Sphalerite (with Bitumen and Galenite) | 1 | Oronogo, Mo | | |
| 1954 | " | " | Topaz (yellow) | 1 | Brazil, S. A | | |
| 1955 | " | " | Quartz coated with Smithsonite (carb of zinc.) | 1 | Chatham. N. Y | | |
| 1956 | " | " | Opal | 1 | Mexico | | |
| 1957 | " | " | Apophyllite | 1 | Bergen Hill, N. J | | Changing to Thomsonite. |
| 1958 | " | " | Staurolite | 1 | Lisbon, N. Hampshire | | |
| 1959 | " | " | Chrysolite (Olivine) | 1 | Dries Eifel, Europe | | |
| 1960 | " | " | Quartz | 1 | Governeur, N. Y | | Without lateral planes, |
| 1961 | " | " | Quartz | 1 | Antwerp, N. Y | | Without lateral planes. |
| 1962 | " | " | Topaz (pink) | 1 | Brazil, S. A | | |
| 1963 | " | " | Gold | 1 | Virginia | | |
| 1964 | " | " | Siderite and quartz in Geode....[Specular iron. | 1 | Illinois | | |
| 1965 | " | " | Quartz without lateral planes and Hematite, | 1 | Cumberland, Eng | | |
| 1966 | " | " | Quartz and chalcopyrite | 1 | Ellenville, N. J | | |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

| Seiral Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1967 | Nov. 1876 | Geo. F. Kunz | Calcite (Dog-tooth Spar) | 1 | Rossie, N. Y. | | Doubly terminated |
| 1968 | " | " | Pectolite | 3 | Bergen Hill, N. J. | | Friable |
| 1969 | " | " | "Zonochlorite" | 4 | Hud. Bay Co., Ter. B. A. | | |
| 1970 | " | " | Cryst. Samarskite with Xenotime | 1 | North Carolina | | |
| 1971 | " | " | Smithsonite and Sphalerite (Blende) | 1 | Bethlehem, Pa. | | |
| 1972 | " | " | Graphite | 2 | Ticonderoga, N. Y. | | |
| 1973 | " | " | Wad | 1 | Near Franklin, N. J. | | |
| 1974 | " | " | "Stevensite," Datolite and Natrolite | 1 | Bergen Hill, N. J. | | |
| 1975 | " | " | Sphalerite (Blende) | 2 | Oronogo, Mo. | | Showing cleavage |
| 1976 | " | " | Amphibole (Asbestus) | 1 | Staten Island | | |
| 1977 | " | " | Serpentine (Picrolite) | 1 | Franklin, N. Y. | | |
| 1978 | " | " | Serpentine (Picrolite) | 2 | Roseville, N. J. | | |
| 1679 | " | " | Calcite (Stalactite) | 1 | Mammoth Cave, Ky. | | |
| 1980 | " | " | Opal (Cacholong) | 10 | Georgia | | |
| 1981 | " | " | Cyanite (Rhætizite) | 1 | Germany | | |
| 1982 | " | " | "Chrome Sand" | Ind | Media, Pa. | | |
| 1982 | " | " | Quartz | 4 | Gouverneur, N. Y. | | Without lateral planes |
| 1984 | " | " | Chlorastrolite | Ind | Isle Royale, Lake Sup. | | |
| 1985 | " | " | Quartz (Carnelian) | 1 | Germany | | |
| 1986 | " | " | Corundum (Emery) | 2 | Chester, Mass. | | |
| 1987 | " | " | Galenite | 4 | Oronogo, Mo. | | |
| 1988 | " | " | Galenite | 1 | Oronogo, Mo. | | |
| 1989 | " | " | Cuprite | 8 | Chessy, France | | |
| 1990 | " | " | Andalusite (Chiastolite, or Macle) | 1 | Massachusetts | | |
| 1991 | " | " | Gold Quartz | 1 | California | | |
| 1992 | " | " | Tephroite | 4 | Franklin, N. J. | | |
| 1993 | " | " | Silver and Gold | 1 | Colorado | | |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 1994 | Nov. 1876 | Geo. F. Kunz | Magnetite (Loadstone) | 75 | Magnet Cove, Ark | | |
| 1995 | " | " | Magnetite (Sand) [(Jeffersonite) | 1 | Port Ontario, N. Y | | |
| 1996 | " | " | Brown Garnet and Iron Garnet on Pyroxene | 1 | Franklin, N. J | | |
| 1997 | " | " | Orthoclase (Chesterlite) | 1 | Chester Co., Pa | [group | |
| 1998 | " | " | Gypsum (Selenite) | 1 | Lockport, N. Y | Niagara | |
| 1999 | " | " | Crystallized Pectolite | 10 | Bergen Hill, N. J | | |
| 2000 | " | " | Laumontite and Crystallized Pectolite | 3 | Bergen Hill, N. J | | Very rare |
| 2001 | " | " | Wulfenite | 1 | Tecoma Mine, Utah | | |
| 2002 | " | " | Quartz (Yellow Jasper) | 1 | California | | |
| 2003 | " | " | Calamine, Sphalerite and Greenockite | 2 | Granby, Mo | | |
| 2004 | " | " | Chlorastrolite | 2 | Isle Royal, Lake Sup | | Rare, in rock |
| 2005 | " | " | Sphalerite (Blende) and Quartz | 1 | Phœnixville, Pa | | |
| 2006 | " | " | Black Tourmaline | 1 | Kingsbridge, N. Y. City | | |
| 2007 | " | " | Zincite (with Calcite) | 1 | Franklin, N. J | | |
| 2008 | " | " | Brucite (Nemalite) | 1 | Hoboken, N. J | | |
| 2009 | " | " | Amphibole (Hornblende) in Quartz | 2 | Chester, Mass | | |
| 2010 | " | " | Zaratite | 1 | Wood's Mine, Lan. co. Pa | | |
| 2011 | " | " | Epidote | 1 | Massachusetts | | |
| 2012 | " | " | Orthoclase (Flesh colored Feldspar) | 2 | New York City | | |
| 2013 | " | " | Oligoclase | 1 | New York City | | |
| 2014 | " | " | Seybertite (Clintonite) | 1 | Franklin, N. J | | |
| 2015 | " | " | Zincite (with Calcite) "Sussexite" | 1 | Franklin, N. J | | |
| 2016 | " | " | Greenockite | 1 | Granby, Mo | | Of the following Nos. to No. 2063, |
| 2017 | " | " | Siderite | 1 | Roxbury, Conn | | nearly all were collected by |
| 2018 | " | " | Gmelenite | 1 | Bergen Hill, N. J | | [Chas. Clifton, about 1860, from |
| 2019 | " | " | "Feldspar" | 1 | Chester, Pa | | near Easton, Pottsville, and the |
| 2020 | " | " | Limonite | 24 | Near Easton, Pa | | coal and iron district bordering. |

*Catalogue of Specimens Registered in the General Museum in 1877*—Continued.

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| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 2021 | Nov. 1876 | Geo. F. Kunz | Limonite [Fibrous] | 5 | Near Easton, Pa | | |
| 2022 | " | " | Limonite | 9 | PompeysMarsh nrE'st'n | | |
| 2023 | " | " | Limonite [Stalactitic] | 1 | Easton, Pa | | |
| 2024 | " | " | Limonite | 4 | Franklin, N. J | | |
| 2025 | " | " | Limonite | 2 | Pottsville, Pa | | |
| 2026 | " | " | Limonite | 4 | Altoona Pa | | Alleghany Furnace |
| 2027 | " | " | Limonite | 5 | Chestnut Hill, Pa | | |
| 2028 | " | " | Limonite | 2 | Bennington Furnace,Pa | | |
| 2029 | " | " | Limonite [Septaria of] | 1 | Hopewell, Pa | | |
| 2030 | " | " | Limonite [fossil] | 2 | Bedford, B. Co. Pa | | |
| 2031 | " | " | Limonite [fossil] | 3 | Hopewell, Pa | | |
| 2032 | " | " | Limonite [fossil] | 1 | Columbia Co. Pa | | |
| 2033 | " | " | Limonife [fossil] | 1 | Near Altoona, Pa | | |
| 2034 | " | " | Hematite [Red] | 3 | Near Easton, Pa | | |
| 2035 | " | " | Hematite [brown] | 3 | Pompey's Marsh, Pa | | |
| 2036 | " | " | Hematite [brown] | 2 | Bennington Furnace,Pa | | |
| 2037 | " | " | Hematite [fossil] | 1 | Near Easton, Pa | | |
| 2038 | " | " | Hematite [fossil] | 12 | Brush Hill, Pa | | |
| 2039 | " | " | Hematite [fossil] | 1 | Henry Furnace, Pa | | |
| 2040 | " | " | Hematite [fossil] | 2 | Bennington Furnace,Pa | | |
| 2041 | " | " | Hematite [fossil] | 3 | Altoona, Pa | | |
| 2042 | " | " | Hematite [fossil] | 1 | Lewiston, Pa | | |
| 2043 | " | " | Hematite [fossil] | 1 | Mt. Savage, Pa | | Camberland Furnace |
| 2044 | " | " | Hematite | 1 | Danville, Pa | | |
| 3045 | " | " | Siderite | 4 | Hopewell Furnace, Pa. | | |
| 2046 | " | " | Siderite [Shale] | 1 | Trantbree Tunuell, Pa. | | |
| 2047 | " | " | Siderite and Limonite | 1 | Hopewell Furnace, Pa. | | |

*Catalogue of Specimens Rigistered in the General Museum in 1877*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 2048 | Nov. 1877 | Geo. F. Kunz | Siderite | 1 | Hopewell, Pa | | Siliceous 23 |
| 2049 | " | " | Siderite | 2 | Easton, Pa | | |
| 2050 | " | " | Hematite (Specular Iron] | 2 | Lake Superior Region | | |
| 2051 | " | " | Hematite (Specular Iron) | 1 | Near Pottsville, Pa | | |
| 2052 | " | " | Hematite (Specular Iron) | 2 | Near Easton, Pa | | |
| 2053 | " | " | Hematite (Specular Iron) | 1 | Pottsville, Pa | | |
| 2054 | " | " | Pipe Ore | 1 | Pottsville, Pa | | Bay Ridge Mountain Coal Field |
| 2055 | " | " | Calcite and Siderite | 1 | Easton Pa | | |
| 2056 | " | " | Magnetite | 4 | Mt. Hope, N. J | | |
| 2057 | " | " | Magnetite | 2 | Dover, N. J | | |
| 2058 | " | " | Magnetite (Magnetic Iron) | 1 | Cornwall, Leban'n co Pa | | |
| 2059 | " | " | Magnetite and Pyrite | 2 | " " | | |
| 2060 | " | " | Magnetite and Pyrite | 1 | " " | | |
| 2061 | " | " | Pyrite | 1 | Near Easton, Pa | | |
| 2062 | " | " | Magnetite ? | 3 | Cornwall, Leban'n co Pa | | |
| 2063 | " | " | Iron Ore | 1 | Bedford county, Pa | | |
| 2064 | " | " | Sodalite with Cancrinite and Lepidomelane | 1 | Litchfield, Me | | |
| 2065 | " | " | Peculiar Slags from Furnaces | 2 | Alleghany, Pa | | Same Note Applies as to No. 2020 |
| 2066 | " | " | Calcite (Flux) | 1 | Easton, Pa | | " " " " 2020 |
| 2067 | " | " | Slag Crystals from Furnaces | 1 | Easton, Pa | | " " " " 2020 |
| 2068 | " | " | Mineral Coal (Anthracite) | 2 | Pottsville, Pa | | " " " " 2020 |
| 2069 | " | " | Beryl (Aquamarine) | 1 | Liberia | | |
| 2070 | " | " | Cassiterite (Stream Tin) and Topazes | Indf | Durango, Mexico | | |
| 2071 | " | " | Cassiterite (Stream Tin) | Indf | Durango, Mexico | | |
| 2072 | " | " | | 1 | | | Believe it Artifi. (G. F. K.) As 2020 |
| 2073 | " | " | Siderite (Carb. of Iron, Shale | 2 | Mt. Savage, Pa | | Same Note Applies as to 2020 |
| 2074 | " | " | | 1 | Summit Furnace, Pa | | " " " 2020 |

## *Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. When. | Obtained. Whence. | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| 2075 | Nov. 1876 | Geo. F. Kunz | "Fire Clay" | 2 | Mt. Savage, Pa. | | Same note applies as to 2020 |
| 2076 | " | " | Coal Shale | 1 | Pottsville, Pa. | | Same note as 2020, about 400 feet above main view |
| 2077 | " | " | Limestone Ore (No. 1) | 1 | " | | The following six are from a mine near Pottsville |
| 2078 | " | " | "Slate Fins" (No. 2) | 1 | " | | About 4 feet above main vein |
| 2079 | " | " | "Sandy Fin" (No 3) | 1 | " | | " 31 " " |
| 2080 | " | " | "Lime Fin" (No. 4) | 1 | " | | " 20 " " |
| 2081 | " | " | "Upper Bastard (No. 5) | 1 | " | | " 17 " " |
| 2082 | " | " | "Fin Vein of Ore". (No. 6) | 1 | " | | " 17 " " |
| 2083 | " | " | " (No. 7) | 1 | " | | With 4 fluid cavities marked wth |
| 2084 | " | " | Quartz | 1 | Near Hot Springs, Ark. | | [ink. |
| 2085 | " | " | Calamine (blue) | 2 | Franklin, N. J. | | Crystal showing "O plane" of |
| 2086 | " | " | Calcite | 1 | Bergen Hill, N. J. | | [Dana |
| 2087 | " | " | Microlite and Uraconite (Uranochre) | 1 | North Carolina | | |
| 2088 | " | " | Chloritoid (Masonite) | 1 | Smithfield. L. Island | | |
| 2089 | " | " | Apatite, Pyrite and Graphite | 1 | Franklin, N. J. | | |
| 2090 | " | " | Quartz and Epidote | 1 | " " | | |
| 2091 | " | " | Calcite coated with quartz (Chalcedony) | 1 | Bergen Hill, N. J | | |
| 2092 | " | " | Decomposing Pectolite and Prehnite | 1 | " " | | |
| 2093 | " | " | " Chalcopyrite | 1 | " " | | |
| 2094 | " | " | Pseudo Talc (Steatite) | 1 | " " | | |
| 2095 | " | " | Franklinite and Calcite | 2 | Franklin, N. J. | | |
| 2096 | " | " | Franklinite and Calamine | 1 | " " | | |
| 2097 | " | " | Wernerite (Scapolite) and Apatite | 1 | " " | | |
| 2098 | " | " | Oligoclase | 1 | New York City | | |
| 2099 | " | " | Amphibole (Asbestus) | 5 | Franklin, N. J. | | |
| 2100 | " | " | Labradorite | 1 | Louis County, N. Y | | |
| 2101 | " | " | Graphite and some other mineral | 1 | New York | | |

*Catalogue of Specimens Registered in the General Museum in 1877.*—Continued.

| Serial Number. | Obtained. | | NAME. | No. of Specimens. | Locality. | Formation | Collector and Remarks. |
|---|---|---|---|---|---|---|---|
| | When. | Whence. | | | | | |
| 2102 | Nov. 1879 | Geo. F. Kunz | Catlinite | 1 | Pipestone Co., Minn. | | |
| 2103 | " | " | Quartz containing fluid and mineral coal (Anth.) | 1 | Herkimer Co., N. Y. | | |
| 2104 | " | " | Barite | 1 | Franklin, N. J | | |
| 2105 | " | " | Spodumene | 1 | Maine | | |
| 2106 | " | " | Zincite and Calcite Spartaite | 1 | Franklin, N. J | | |
| 2107 | " | " | Garnet on Zincite (Schist) | 4 | Franklin, N. J | | |
| 2108 | " | " | Franklinite, Zincite and Calcite (Spartaite) | 1 | Franklin, N. J | | |
| 2109 | " | " | "Mica" | 1 | Chester, Pa | | |
| 2110 | " | " | Pyrite (octahedral) | 2 | Bergen's Hill, N. J | | |
| 2111 | " | " | Quartz (Amethyst, doubly terminated) | 6 | Brazil | | |
| 2112 | " | " | Perofskite | 4 | Magnet Cove, Ark | | |
| 2113 | " | " | Pyroxene (in lava) | 15 | Vesuvius, Italy | | |
| 2114 | " | " | Brucite | 2 | | | |
| 2115 | " | " | Calcite (Stalactite) | 2 | | | |
| 2116 | " | " | Serpentine | 1 | St. Lawrence Co., N. Y. | | |
| 2117 | " | " | Calamine on Sphalerite | 1 | Granby, Mo | | |

# INDEX TO THE GEOLOGICAL REPORT.

PAGE.

## ERRATA.

On page 3, insert "the" before Geological.
On page 3, for "Dec. 31, 1877," read May 25, 1878.
On page 27, fifth line from top, for "lining" read limy.
On page 28, first line from top, for "6.44" read 6.21.
On page 28, first line from top, for "32.287" read 31.287.
On page 28, second line from top, last column in table, for "0" read 9.
On page 43, for "Reconnoisences" read Reconnoissances.
On page 48, eighth line from bottom, for "moutone-ed" read *moutonne-ed*.
On page 53, second line from bottom, for "scantly" read scantily.
On page 55, third line from bottom, for "60" read 27.
On page 59, twelfth line from bottom, for "nolithic" read neolithic.
On page 68, third line from the top, for "Thus" read This.
The 69th and 70th pages should exchange places.
On page 75, at bottom, add Ilex verticellata, *Gray*, Black alder.
On page 82, fourteenth line from top, for "Chæteets" read Chætetes.
On page 83, twenty-fourth line from the bottom, for "organized" read recognized.
On page 99, seventeenth line from bottom, for "southwestern" read southeastern.
On page 123, third line from top, for "exposuse" read exposure.
On page 123, sixth line from top, for "mills" read miles.
On page 129, fourth line from bottom, for "62" read 52.
On page 201, strike out "Rock on which Duluth is built."
On page 216, the words "with 4 fluid cavities marked with ink," and "crystal showing 'o plane of Dana," should each be placed a line lower on the page.